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THE

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THE HEILMANN ELECTRIC LOCOMOTIVE.

THIS contrivance, of which we have been hearing so much lately, was tried (February 10th) on the main line of the Chemin de Fer de l'Ouest, Havre to Beuzeville, a distance of about 16 miles, being selected as affording a convenient run. Stated briefly, this electric engine is made up of a steam engine, a dynamo, and motors on the axles. Between the steam power and the driving wheels there is interpolated, in fact, a dynamo and motors. The whole contrivance, indeed, is a locomotive carrying a central station on its back.

As an engineering arrangement, such a device seems, at the very least, to be complicated. An engineer who read a description of the Heilmann locomotive, has suggested improvements upon it which remind one somewhat of the story of a man who took out a patent for improvements upon the South Eastern Railway. Our friend's suggestion is to lay a continuous Ramsbottom water trough between the rails, and to scoop up the water into a tank, as is done by so many express engines already. From the tank he would pass the water through a centrifugal pump worked by an electric motor, and the water issuing under pressure from a nozzle would work a Pelton wheel. This, in turn, would actuate a dynamo to supply current to motors on the axle. Asked as to how he would arrange the water troughs on the gradients, he had a ready answer. The electricity running to waste from the motors would flow down a scoop turned the reverse way, and into the water trough, where it would mix up with the water and "sort of" magnetise it, "so it would stick to the trough.' There didn't seem to be any coal burned in our friend's arrangement—a desirable end attained by carefully confusing the various causes and effects in the different transformations effected, until the "engine didn't know how many of each kind there were," much as an ordinary locomotive is said, when running forward, to continue so to do after the link motion is put into middle notch, whereas if it is set to run backward it will also continue to run *that* way when in middle notch.

In the Heilmann engine there is not even a pretence of doing without coal, and to judge of what we hear of the steam engine portion, we should think that it will consume more coal per horse-power than an ordinary locomotive, and, moreover, even if it did not do so, there remains the two losses in the electric transformations to be taken into account. It is not very reasonable, then, to expect a very great economy in this novel machine.

Mr. F. B. Lea, who communicates, as an eye-witness, an account of the trial to an electrical contemporary, appears, however, to lay stress upon the abolition of reciprocating parts connected to the driving wheels. We really cannot see much

in this; the reciprocating parts are there all the same, and are producing vibration somewhere, even if they reduce the so-called hammer-blow upon the rail. This effect of reciprocating parts has, however, never been seriously grappled with in the steam locomotive. Even in American locomotives, with their small wheels, and clumsy, badly-designed, and heavy reciprocating, parts, it is claimed that a rate of 100 miles per hour has been attained, and with English patterns the same can be done with greater safety. But if the unbalanced vertical counterweight action is to be entirely got rid of, it can be done any day by the use of three cylinders upon one axle, the central one having moving parts of double the weight of each of the outer ones, and of opposite motion.

But, as regards the utilising of all axles for adhesion, we think Mr. Lea lays too much stress upon this. It is only at low speeds that the adhesion of a single pair of drivers is insufficient to prevent slipping when driven by cylinders that will develop 800 or 1,000 horse-power at a high speed.

Now what are the proportions of the Heilmann engine? It has a boiler 26 feet long and 76 inches diameter. The engine is compound, having cylinders 16¾ inches and 25⅝ inches diameter, with a stroke of 12 inches. The pressure is not stated, but must be pretty stiff to give a brake horse-power of 600 at 300 revolutions, and 800 H.P. at 500 revolutions.

The dynamo, by Brown, Boveri & Co., is a six-pole machine, with a 49-inch ring armature wound for 400 volts and 1,025 ampères at 300 revolutions. On each of the eight axles of the two four-axle bogies is an iron-clad four-pole motor with a 25½-inch armature. The driving wheels are only 45½ inches diameter.

We are glad to see that Mr. Lea doubts the soundness of the design of the engine, though, on the whole, he states that the entire locomotive is a good piece of work. It might easily be all that, and yet be anything but a sound affair on general principles.

If there be any advantage in having no direct connection of an engine with the driving wheels, we should think that every claim put forward in our contemporary could be carried into effect with less loss of efficiency by adopting a system of rope-driving for this purpose.

Our old friend, the lowered centre of gravity, is trotted out as a spectral authority for condemning the present locomotive, and yet it is well known that engines with high placed boilers run more steadily than those with a low centre of gravity. It seems a sort of fashion to glorify a low position of centre of gravity. If we did not feel perfectly assured that Mr. Lea knew better, we should ask him, why not excavate a trough between the rails and hang the centre of gravity down there. We cannot congratulate our contemporary upon the illustrations of the new locomotive. The view showing engine, generator, and exciter, is a cloudy affair, that would pass muster very well as a moonlight view of a scrap heap, while the general view of the whole affair teaches just nothing, but resembles an American box car in tow of a huge side tank locomotive.

One is tempted to ask, how is it possible that such a machine could have been constructed. Whence the capital? We need not inquire, it is all set down; Mons. Heilmann is managing director of the railway. *Hinc illæ lachrymæ.*

Photographing the Spectrum of Lightning.

A METHOD of obtaining a photograph of the spectrum of lightning is described by G. Meyer in *Wiedemann's Annalen*, Vol. v., p. 416. To obtain a photograph of the spectrum of lightning with the spectroscope having a slit, it is necessary that the lightning flash should be exactly in the line of the optical axis of the apparatus. As this is very difficult to attain, the author employed instead of the spectroscope, a diffraction grating. A diffraction grating on glass was fixed in front of the photographic lens focussed on the horizon. By this arrangement an image of the flash due to the direct rays was obtained, and on each side a spectrum of the flash, containing a number of lines corresponding to the bright lines of the spectrum of the substances heated by the flash. In the experiment an ordinary landscape lens of 10 cm. aperture was used. In front of this was fixed a glass grating of a ·0256 mm. gauge. Two plates were exposed; the first showed two flashes, and to the right and left of each, were images corresponding to lateral spectra of the first degree containing only one line; the second plate showed more flashes close to the horizon. One bright flash showed a distinct lateral spectrum line, and measurements showed that this corresponded approximately to a wave length of $382 \cdot 10^{-6}$ mm.; the measurements were not sufficiently exact to say with certainty to what substance this line belonged; there may also be other ultra violet lines to be discovered, with better apparatus and more favourable conditions, say with a flash only a few hundred metres distant. In previous experiments with the spectroscope by *Schuster* and *Vogel*, the longest wave length obtained was $568 \cdot 10^{-6}$ and the shortest $458 \cdot 10^{-6}$.

Prof. Robinson on St. Pancras Electric Lighting.

IN a paper read at the Society of Arts, the plant used by the St. Pancras Vestry was minutely described by Prof. Robinson. His remarks are of but little interest to electricians; for the most part they consisted of eulogisms on his own plans, and the manner in which he and some assistants had carried them out. No information of any value whatever was given regarding the working of the roof condensers, about which we understand there are considerable doubts as to its utility—night and day clouds of steam are at any time to be seen over St. Pancras Stanhope Street Station. A direct question as to how far the dry air machine affected the subterranean culverts the Professor declined to answer. In a table of costs, he gives the cost of fuel per unit as 1·21d., marked with an asterisk. In a footnote we observe the remark "This is more than it should have been"; if it were so, it was due to his audience and to his employers, the St. Pancras Vestry, to state what it should have been, and why it was more than that figure. There was nothing controversial in the paper said Prof. Robinson; that is quite true, but in his last words, replying to the discussion, he made assertions regarding the question of alternating *versus* continuous currents, which display a very slight acquaintance with the subject, and which could have been controverted with ease by any electrician. There was so little in the paper to discuss that those who spoke upon it scarcely referred to it at all, but referred to schemes of their own. Mr. Shoolbred talked about the Bradford installation; Mr. Kapp about Bristol; Mr. Preece about the "poor man's light" (paraffin oil we presume); and Mr. Halpin wandered into a treatise on condensers in general, particularly avoiding reference to the St. Pancras roof condensers. In concluding this brief notice of this paper, we may say that at various times we have obtained information which would lead us to believe that everything does not work so smoothly as the Professor's paper assumes.

DISTURBANCES IN DYNAMOS.*

By J. A. MONTPELLIER.

(*Concluded from page* 178.)

IV.—Excessive Noise or Vibration Observed in the Dynamo whilst at Work.

52. When we observe an abnormal amount of noise or excessive vibrations in a dynamo whilst at work, we must immediately seek out the cause, and for that purpose proceed to a careful examination of the machine. As a rule, the disturbance is attributable to one of the following causes :—

A. Bolts loose.

B. The ends of the axle, the boss of the pulley, or the edge of the belt knocking against the bearings.

C. The armature or the pulley badly balanced.

D. The armature knocking against the pole pieces.

E. Joint in the belt flapping on the pulley.

F. Humming caused by the teeth of the core of the armature when passing before the pole pieces.

G. The brushes badly fixed and grinding on the collector.

The vibrations may also be attributable to the fact that the framework of the dynamo is badly fixed to the ground.

53. A.—*Bolts loose.*—An attentive examination of all the parts bearing bolts, such as the bearings, pulley, &c., is sufficient to show the faulty parts. This defect, which is of frequent occurrence, may very easily be avoided if we take the precaution to look at all the bolts and all the parts likely to become unscrewed whenever the dynamo is about to be started.

54. B.—*The ends of the Axle, the Centre of the Pulley, or the edge of the Belt knocking against the Bearings.*—These defects are easily discovered ; a simple examination of the parts in question is all that is required. When once the faulty part is discovered, we have merely to put the axle on the lathe so as to give more play between the ends, to shift the pulley on the axle, so that it gives no more shocks, or, lastly, to stretch the belt so that it no longer slips on the pulley, and so ceases to rub against the bearings. In certain cases, we can arrive at the same result by filing the edges of the bearings.

55. C.—*Armature or Pulley badly Balanced.*—On placing the hand on the framework of the dynamo whilst working, strong vibrations are felt, which vary in intensity with the changes of speed imparted to the dynamo.

In this case, it is necessary to test the armature and the pulley separately. To do this, we remove the axle and the armature, and place them, as shown in fig. 7, on two metallic

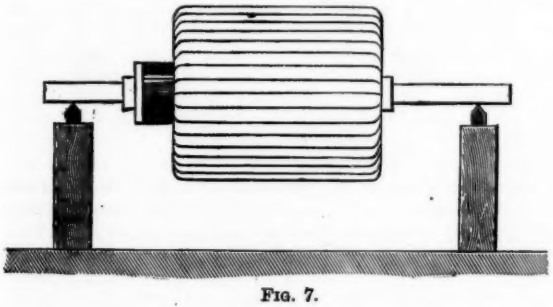


Fig. 7.

cross-bars, placed quite horizontally by means of a level, and at a sufficient distance from one another for the armature to turn freely between them ; it is preferable that the upper part of these cross-bars on which the axle rests, should be knife-edged. This being arranged, the armature is slowly turned by hand, backwards and forwards, and it will then be very easy to see whether one of the sides is heavier than the other, or, in a word, whether the armature is badly balanced, by the tendency which the heavier part will have to fall to the bottom. When the test shows that there is a defect of this kind, it may be corrected by fixing *very securely* to the lighter side an additional leaden weight.

* *L'Electricien.*

A defect in the balancing of the pulley may be ascertained and corrected in the same way.

56. D.—*The Armature knocking against the Pole Pieces.*—When the winding is badly fixed, it may cause this defect. In any case, we have only to turn the armature and examine the surface carefully to see if there is anything abnormal, and lastly to see whether there is everywhere between the armature and the pole pieces a free space, which should not be less than 1·5 millimetres. It is thus easy to see, by turning the armature slowly, by hand if possible, whether any part is rubbing against the surface of the pole pieces.

The fault can easily be repaired by hammering down the projecting parts, and by putting back and securing any wires that are loose. We can also, if the fault cannot be remedied in any other way, file the inside of the pole pieces at the place where they are rubbed by the armature.

57. E.—*Joint in the Belt flapping on the Pulley.*—When the joint is badly made and is of greater thickness than the rest of the belt, it frequently happens that at the moment when the join passes over the pulley a loud noise is heard, which is repeated at regular intervals, that is, every time it passes round the pulley.

When this defect is ascertained, either the joint must be re-made or an endless belt must be employed.

58. F.—*Humming caused by the Teeth of the Core of the Armature when passing before the Pole Pieces.*—With toothed armatures there is always a slight humming while the dynamo is working. But this noise does not constitute a defect ; there is therefore no need to trouble about it unless it is when the dynamo is being tried for the first time, and then only if the humming is very noticeable, as in that case it would proceed from a defect of construction, such as the transverse section of the teeth being too small, or the ridges at the extremities of the pole pieces too pronounced, &c.

When the humming increases perceptibly in a dynamo that has already worked well, it may be owing to the exciting current being too intense. It can easily be ascertained whether this is the case, and if so, all we have to do is to increase the resistance of the excitation rheostat.

59. G.—*The Brushes badly fixed and grinding on the Collector.*—If we put our ear to the collector we can easily tell whether the fault lies in that part ; moreover, sparks may be produced.

Loose brushes, inequalities on the collector, brushes too hard, or if carbon brushes are used and the material is stony, bad fixing, are all causes that are calculated to produce a considerable amount of noise.

When once the cause of the noise is ascertained, it can easily be remedied, either by very slightly oiling the collector with a rag, or by removing its inequalities either by means of a file, emery paper, or the lathe, or, lastly, by regulating the position of the brushes and securing them firmly in the brush-holders.

V.—The Armature does not Turn at its Normal Speed.

60. The speed of the dynamo is ascertained by means of a speed-counter, and we can then see whether any slackening or acceleration of speed occurs, the motor working always at the same rate.

This disturbance may proceed from the following causes :

A. Overload of the dynamo.

B. Short-circuit in the armature.

C. Bushes too tight, or dust and foreign bodies in them.

D. The armature rubbing against the pole pieces.

61. A.—*Overload of the Dynamo.*—The slackening of the speed of the armature is accompanied by an abnormal production of sparks at the brushes, and by the heating of the bearings and the armature. Moreover, the belt is tightly strained and the ampèremeter shows an excessive strength of current.

The slackening of speed, therefore, is merely a consequence of the disturbance (see Sections 23, 24, 25 and 26 for instructions for finding the fault and repairing it).

62. B.—*Short-circuit in the Armature.*—This disturbance is also characterised by abnormal heating of the armature and by the production of sparks at the brushes. Proceed as indicated in Sections 31 and 37.

63. C.—*Bushes too Tight, or Dust and Foreign Bodies in Them.*—Abnormal heat is produced at the same time in

the bushes, and we must proceed as shown in Sections 46 and 48. The disturbance may also be due to defective lubrication (see Section 45).

64. D.—*The Armature Rubbing against the Pole Pieces.*—This disturbance has already been discussed in paragraph 56. It is characterised not only by a slackening of speed, but also by the production of abnormal noise.

Recapitulation.—After having described the principal causes of disturbance that may affect the regular working of a dynamo, we thought it might be useful to sum them up in a table, which would be easier to consult, and in which the reader would be referred to the sections in which he would find all the necessary details.

Summary of the Disturbances of most Frequent Occurrence in the Working of Dynamo-Electric Machines.

I.—*The Dynamo gives no Current.*—A.—Residual magnetism of the field-magnets too feeble (4).

B.—Defective contacts (5).

C.—Short-circuiting, or bad insulation, in the working parts of the dynamo or in the external circuit (6). (*a*) Bad insulation of the terminals of the dynamo (7); (*b*) Bad insulation of the brush holders (8); (*c*) Bad insulation of the magnet bobbins (9); (*d*) Short-circuiting in the magnet bobbins (10, 11); (*e*) Short-circuiting in the commutator (12); (*f*) Short-circuiting at any point of the circuit (13, 14, 15).

D.—Open circuit in the working parts of the dynamo, or in the external circuit (16). (*a*) Interruption in the circuit of the field-magnets (17); (*b*) Interruption in the circuit of the armature (18); (*c*) The brushes not resting on the collector (19); (*d*) Interruption in the external circuit (20).

E.—Reversing of the bobbins of the field-magnets.

II.—*Large Sparks are Produced at the Brushes.*—A.—Overloading of the dynamo (23). (*a*) Abnormal voltage (24); (*b*) Current too great (25); (*c*) Bad insulation of the external circuit (26).

B.—The brushes badly fixed (27).

C.—The collector in bad condition (28).

D.—The brushes and brush holders in bad condition (29).

E.—Interruption in the armature circuit (30).

F.—Short-circuiting in the armature (31).

G.—Defective insulation of a magnet coil (32).

H.—Weakness of the inductive magnetic field (33).

III.—*Abnormal Heat is Produced in the Working Parts of the Dynamo.*—A.—Heating of the armature (35). (*a*) Current in the armature too great (36); (*b*) Short-circuit in the winding of the armature (37); (*c*) Foucault currents in the core of the armature (38); (*d*) Dampness of the armature bobbins (39).

B.—*Heating of the Magnets* (40), (*a*) Exciting current too great (41); (*b*) Dampness of the inductive coils (42); (*c*) Foucault current in the pole pieces (43).

C.—*Heating of the Bearings* (44). (*a*) Defective lubrication (45); (*b*) Dust and foreign bodies in the bushes (46); (*c*) Axle twisted, out of line, or not turned true (47); (*d*) Bushes out of line, or too tight (48); (*e*) The centre of the pulley, or the collar of the axle pressing against the bushes (49); (*f*) Belt too tight (50); (*g*) The armature too near one of the pole pieces (51).

IV.—*The Dynamo Produces Excessive Noise, or Vibration, whilst Working* (52).—A.—Bolts loose (53).

B.—The collars of the axle, the centre of the pulley, or the edge of the belt, rubbing against the bearings (54).

C.—The armature, or pulley, badly balanced (55).

D.—The armature rubbing against the pole pieces (56).

E.—Joint in the belt flapping on the pulley (57).

F.—Humming caused by the teeth of the core of the armature when they are passing before the pole pieces (58).

G.—The brushes badly fixed and grinding on the collector (59).

V.—*The Armature does not Turn at its Normal Speed* (60).—A.—Overloading of the dynamo (61).

B.—Short-circuit in the armature (62).

C.—Bearings too tight, or foreign bodies and dust in the bushes (63).

D.—The armature rubbing against the pole pieces (64).

The numbers in brackets refer to the sections relating to the defect observed.

As we said at the beginning of this article, it is almost impossible to give a series of absolutely fixed rules, providing for all the disturbances which may arise during the working of dynamos.

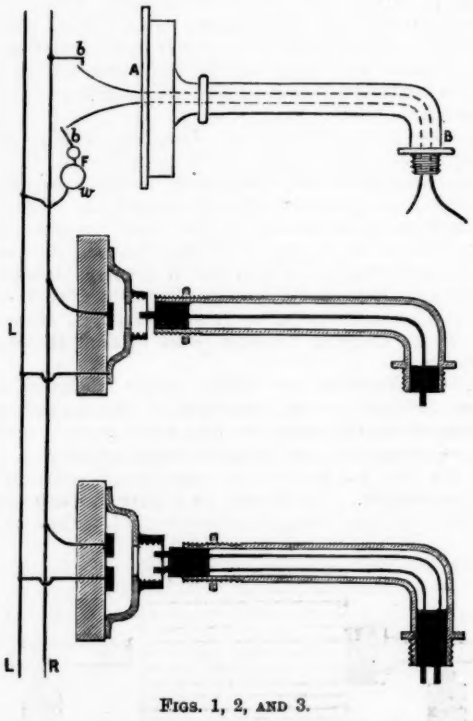
We hope, nevertheless, that this sketch will be of some utility, and will save those entrusted with the care of these machines from losing much valuable time. It may, possibly, contain some errors, and if our readers observe any we should be greatly obliged if they would point them out.

RULES AND REGULATIONS FOR ELECTRIC LIGHTING STEAMSHIPS.

By RANKIN KENNEDY.

II.

Electric light fittings for ships are, in many instances, not at all suited to their purpose. In many catalogues common gas fittings, like fig. 1, are offered for ship fittings. They may be more or less elaborately embellished, and silver plated, but fig. 1 will serve as an illustration of the "electric" principles upon which they are constructed. It will be observed that the electric part of them consists of two insulated wires pulled through the tube.



Figs. 1, 2, and 3.

It seems strange to the electrician to find rules called fire office rules insisting upon keeping the well insulated conductors apart by a fillet of wood at least 1½ inches in breadth for mains and 1 inch for branches, and, in cases where there is no wood casing, the rule is to keep them 6 to 12 inches apart, and from all conducting substances; and yet in almost every fitting we find the wires touching each other and the brass tubes.

The two ends at B are led into a lamp holder and fixed by screws within ⅜ths or ¼-inch from each other, and the ends, at A, are jointed to the two branch wires leading from the main, L, R. Now, in most cases, the joints at A are made after the branch wire is laid, and the joints are then made before the fitting is screwed up in place. To enable a joint to be made at *b*, *b*, some slack wire is required, and this slack is bundled up under the fitting anyhow, along with joints.

The branch wire is cut again at F for a fuse, and again at W for a switch. It will thus be seen that after keeping our main wires with their insulation intact a foot apart, we finally bring the branch wires connected to them into very close quarters indeed, and with no protection to speak of, either from each

other or from the metal fitting, except the insulation. Is it surprising that in nine cases out of ten all the trouble arising in installations should be traced back to the points A, B, *b*, F, W?

This primitive and barbarous method of wiring fittings still prevails, but other and more workmanlike methods are carried out by good firms.

At a very early date in ship lighting Mr. J. D. F. Andrews devised and carried out a complete system of wiring fittings, called the central contact or concentric system. Its principle may be seen from fig. 2. Here there is some rational method of making an "electric" fitting, producing something better than a gas bracket with two wires pulled through it. An insulator is fixed in each end of the fitting at A and B, and the conductor is firmly held in these insulators, and has projecting terminals of stout brass pins at each end. There are no joints required in fixing up these fittings; screwing on the lamp holder at B makes contact with a central insulated pin, and screwing on the fitting at A makes contact with the pin and a spring plate attached to one of the branch wires; the metal tube forms the return path for the current.

On such a system there can be no doubtful joints at A, and no slack wire packed up under the fittings. A whole ship may be wired complete, and the joints completed without fitting a single fitting in place; and the whole may then be carefully tested and inspected. The fittings can then be screwed up into perfect connections without making a single joint.

Then again, if we use the method illustrated in fig. 1, and an accident happens at sea in the fitting necessitating its removal or substitution, the joints at *b*, *b*, require to be undone and remade again; the wires are pulled about, and, as likely as not, damaged, and, perhaps, if no one on board cares to attempt the job, the faulty bracket is allowed to remain until it causes mischief.

With brackets or fittings made on the principle of fig. 2, they are simply screwed out or in—there are no soldered joints to trouble anyone.

Further consider the B ends: Suppose at sea a holder gets faulty or broken, the engineer in removing it must pull out the two ends and screw them into the new holder. This is no easy job even for an expert workman to accomplish without a short circuit. With fittings like fig. 2, simple screwing off and on is all that is necessary; a child can take off one holder and put on another with perfect certainty of making absolutely perfect contact, and without the slightest danger to the insulation.

The system, fig. 2, is a single wire method, but the principle can be applied to double wiring, of course at an increased cost, and a double-wired ship may have single-wired fittings. Fig 3 is an illustration of double wiring; here the two wires are held in the end insulators, and two contact pins are projected out at A and B. We shall enter fully into the details of all three systems here referred to in future articles.

The systems of fittings, 1, 2, 3, can be used with either of four systems of wiring a ship. The first system of wiring is that indicated by the irrational fire office rules, two separate mains carried apart in wood casing, no part of the system being grounded, with No. 1 style of fittings. Second, concentric wiring not grounded at any point. Third, concentric wiring with one conductor grounded; and fourth, one single insulated main wire with the body of the ship as a return.

The first and fourth are by far the cheapest methods and are most common; the fourth is by far safer and better than the first, as we shall demonstrate.

The second system requires skill in fixing and demands good materials, costs a good deal, but is a first-class job when done. This wiring, with fittings of fig. 2 style, is an ideal system for a first-class installation.

The fourth system, for many steamships, is quite satisfactory if properly carried out. It is cheap and therefore suitable for cargo, cattle, and cheap steamers.

The third system is only an expensive method of carrying out the fourth system, but is cheaper than the second system. It is a single-wire system with a naked return wire ensuring "good earth" throughout, and lends itself readily to special treatment in the matter of joints and fittings.

The first system is one upon which the jerry builder can operate, the wood casing covers up bad joints, poor insulation, and can be run up with little skilled labour.

It is simply a house installation transferred to a ship, in it no special fittings or joints are required; common high insulation wires are run in wood casing with the 1½-inch wood fillet between them; branches are tapped off by baring these wires and making a joint on each by removing two inches or so of the insulation. These joints are then insulated by rubber solution, rubber tape, and prepared tapes sometimes, and Chatterton's compound is used in covering up these joints.

The branch wire terminates, after passing through a switch and fuse, in two joints behind the fitting, and the fitting is only a gas fitting with two wires run through it. The wires, the tape solution and compounds, and the gas fittings can all be readily brought in, and by screwing on a double contact Ediswan holder on the nose of the gas fitting, attaching the lamp and a partially opaque globe, the whole installation can be set up with little skilled labour except that required to nail up the wood casing and solder the joints, and with a 100 guinea engine and dynamo, the whole concern is ready for sea.

It is different with the other systems, the fittings require to be made up specially for the system to be used, special "back blocks" fitted with contacts and screws for terminals to take the ends of the wires require to be made and properly fitted, T, L, + and other junction boxes are required for tapping the mains. In J. D. F. Andrews's new system, these junctions are formed by pouring molten metal in a mould round the insulated joint. In the Fowler-Waring system lead joints are made by plumbers. In the armoured concentric wire system cast-iron junction boxes are used.

It has been considered necessary to give this very brief outline of the systems, to show the difficulties in the way of making rules which may be generally applicable, and also to point out that the main wires and branch wires may be of the very best materials, but by being put into a faulty system the high qualities are lost; the rules must make it impossible to adopt a bad system, they must insist on the use of properly constructed junction boxes or protectors, switches, fuses, and fittings; joints must be reduced to a minimum, and the fittings should be such that they can be taken down and fixed up without making any joints.

Before presenting the rules for discussion, we may examine a few of the fittings and appliances used in the various systems of wiring and fitting out ships with an electric installation.

THERMO-HYDROMETER FOR USE IN ACCUMULATORS.

At the suggestion of Mr. Desmond G. FitzGerald, Messrs. Fletcher, Fletcher & Stevenson, of 21, Mincing Lane, have adapted their thermo-hydrometer for use in accumulators of large or small size. This instrument, which is extensively employed by the manufacturing chemist and druggist, is a neat combination of the thermometer with the hydrometer, and its utility is obvious when it is considered that, strictly speaking, the indications of the latter instrument constitute no accurate criterion of the relative strengths of solutions unless the temperatures are also determined. When it is inconvenient to test with the hydrometer at a constant temperature, say of 15 degrees C. or 60 degrees Fah., the two instruments, or, preferably, the present combination of them, should always be employed.

One of the thermo-hydrometers now before us is 11½ inches in length, whilst the hydrometer scale ranges from 1,050 to 1,300, and the thermometer scale from 30 degrees to 120 degrees Fah. Another instrument, very convenient in the case of small cells, is six inches in length; the limits of specific gravity are the same as above, whilst the temperature may vary from 20 degrees to 140 degrees Fah.

Both in investigations relating to the theory of secondary batteries, and in the practical use of accumulators, the hydrometer is a valuable instrument. Mr. W. H. Preece was, and probably is, a strong advocate for its employment by those who have charge of accumulators. Speaking some seven years ago, at which time he had been using secondary cells practically during three years, he said:—"My practice is this: in every cell there is placed a very carefully adjusted hydrometer, and readings of those hydrometers are taken

every hour while the cells are being charged, and every morning after the cells have been discharged. In the formula that Mr. FitzGerald has given us,

$$Pb\,O_2 + 2\,H_2\,SO_4 + Pb = Pb\,O + H_2\,SO_4 + Pb\,SO_4 + H_2O,$$

it is assumed that the cell has been charged, and when the cell is charged it is at its greatest density, it has dissolved in it the greatest quantity of sulphuric acid. When the cell is discharged it passes through a process by which this sulphuric acid, that gives it (the electrolyte) density, is transferred into sulphate of lead, abstracting from the solution that which gives it weight, and leaving behind virtually a smaller proportion of acid and water. Supposing our cells are charged and have density of 1,210, then in my cells, which are 15L E.P.S. cells, there is a steady fall of one division, or one degree, for every 9 ampère-hours taken out; and it is possible and easy to indicate with absolute accuracy, to one ampère-hour, the quantity of charge that has been taken out of a cell, and the quantity of charge that remains in. Usually the cells which were at 1,210 run down to about 1,190 before they are recharged; * and it is found that in charging, for every 12 ampère-hours put in, an increment of one degree of density is observed on the index."

The practice of having a hydrometer for each cell of an accumulator is one, which, however desirable in the abstract, will certainly not be universally followed. From motives of economy, one hydrometer is usually made to do duty for all the cells in succession. *A fortiori*, this will be the case with the thermo-hydrometer; it is only in special cases—in *éditions de luxe*—that one of these instruments will be placed in each cell.

There is one desideratum in connection with this instrument which some of our physicists may be able to supply, but which, so far as we know, is not at the present moment forthcoming. It is a means for calculating from the hydrometer indication at a given temperature—say 80 or 45 degrees Fah., what would be the indication at a standard temperature—say 60 degrees Fah. In the case of water, if the hydrometer indication be 996·7, which corresponds to the first named temperature, we can ascertain from well-known tables that this density is, roughly, about $\frac{1}{4}$ per cent. below that which would be indicated at the standard temperature. Or, if the hydrometer indication be 999·9, which corresponds to the temperature of 45 degrees Fah., the tables tell us that this density is about ·077 per cent. higher than that corresponding to the standard temperature. Unfortunately, the desideratum is not merely a curve representing the variations of density with temperature in the case of a dilute acid of definite composition, but something much more complicated, to which only a rough approximation may be possible.

The thermometric indications of the instrument may, however, serve a purpose still more useful than that of giving definiteness to or suggesting a correction of the indications of the hydrometer. Whenever the temperature of a particular cell in a series is found to be higher than that of the other cells of the series, the most probable, and, in certain conditions, the only cause of the difference is to be found in local action—electro-chemical waste—occurring in that particular cell. And thus the thermometric indication, if duly noted and acted upon, may not only save the cell from destruction, but also obviate the serious loss of energy which occurs when a cell, exhausted by local action, is traversed by the current from the active elements of the series.

THE BOURNEMOUTH ACCIDENT.

The number of accidents which have occurred in the United States, owing to contact with electrical systems, have been of some frequency. Where such accidents occurred, causing loss of life, due to handling "live" wires, the matter was easily understood, but there were many cases where accidents happened when no "live" wires were about, but where the current must have come directly from the ground and gone again into the ground. A full explanation and investigation of such accidents has not always been forthcoming. Consequently an accident of this character having for the first time occurred amongst us, it is interesting to note how the matter occurred, and what the result of the investigations into its causes may prove, and furthermore, whether there may or may not be a probability of similar accidents happening in the future in the same or other systems of high tension working.

In our last issue we printed a very exhaustive report of Major Cardew's, R.E., who went down to Bournemouth within 24 hours of the accident. The result of his investigations was to prove that there was a fault existing in one of the mains leading to a transformer fixed in the basement of the Imperial Hotel, the faulty wire being in contact with the iron pipe in which were the two mains leading from a joint-box in the roadway. The pipe was resting on brickwork (therefore to some extent insulated), forming a chamber a short distance below the surface. The theory of Major Cardew is that the hind feet of the horse, resting on the ground above the joint-box, practically were charged by the current obtained through the leakage from the faulty main from the iron pipe; that the horse's fore feet making contact with wet or good earth, established a circuit, and that the high pressure current acting upon the horse—proved to have a weak heart—killed it. To quite accept this theory, we must suppose that either the horse was killed by a static charge, assuming the capacity of the cables to be sufficient for the purpose, or that the circuit was established with the opposite pole of the alternator by means of a leak in the other main. Of this there is no proof, but it is quite possible that the leakage of the whole system in the opposite or negative (that is, the outside wire) main was sufficient to allow of a current strong enough to have killed *this* horse, to have passed through—that is, assuming that the fault was in the positive main, which must have been the case. The practical result was that the passage of the current through the horse was due to the fact that the horse offered less resistance than the surrounding earth.

Major Cardew points very strongly to the fact that the insulation of the cable on which the fault occurred was of insufficient thickness for so high an alternating current. Although possibly the megohm resistance of this wire might have originally been high enough, yet its thickness left no margin whatever for safety. A very little mechanical pressure would have made such a wire dangerous, and certainly, as in the present case, unsafe to use. Possibly its use has been prompted partly by economy and partly by necessity, for the size of the leading-in pipe would not admit of using two wires of extra thickness.

The recommendations of the Government Inspector that nowhere should wire be used with a less insulation than $\frac{1}{10}$th of an inch, and that the pipes be all connected together and earthed are of distinct importance. Identical plans, we may state, were practically decided upon by the Bournemouth Company before the issue of the inspector's report, and steps had been already taken to remove all the connections with parallel cables, substituting concentric cables with insulation of $\frac{1}{10}$th of an inch. We may point out that the majority of the cables used by the company have an insulation of that thickness; it was only in the case of some new connections that the reduced insulation was used.

Major Cardew does not altogether free the company from blame—for instance, they were warned in the morning that a horse had been startled at the same place, and he seems to infer that this notice was neglected. This was not the case, for an investigation took place on the spot, the result of which was that it was supposed that the horse was startled by a flapping shutter. Unfortunately this was not the truth, and the fault must have evidently got worse, as a very serious disturbance was felt the same day on the telephone system. It is much to be regretted that the matter was not promptly taken in hand, for the section implicated was known to be faulty.

Bournemouth is known to be peculiarly situated, on account of its "bad" earth, and disturbances are frequent. Such being the case with the working of a powerful high pressure system, nothing should be neglected to prevent such an accident in the future. The station has been working well, and the supply of light has been very steadily increasing and giving satisfaction, and it is to be hoped that when the whole of the system has been thoroughly put right, there will be no further fear of danger.

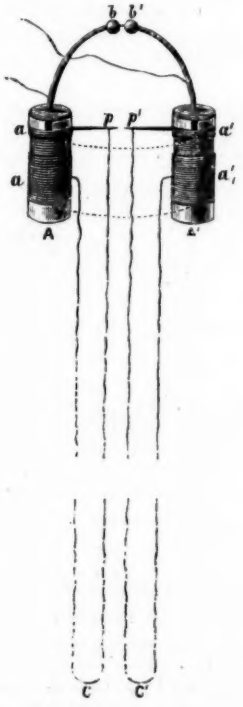
* In this case, only 180 ampère-hours would be taken out; the capacity of the the 15L cell being 330 ampère-hours.

This accident is one which ought to serve as a lesson to all high pressure working stations, not to depart in any way in the underground mains from a perfect system of insulated cables, and to have an insulation whose thickness will provide a large margin of safety. The result of the inquiry points very strongly to the fact that for high pressure working "*concentric*" mains and branches are distinctly preferable to, and safer than, parallel cables. This refers to the high pressure side of the transformer system. On the low pressure side, ordinary low tension mains and branches may be used in parallel.

THE SPEED OF PROPAGATION OF AN ELECTRICAL DISTURBANCE ALONG A COPPER WIRE.

An ingenious method of determining the rate at which an electrical disturbance is propagated along a copper wire was recently described by Mons. R. Blondlot before the Paris Academy of Science. The method is particularly interesting, since it possesess the advantage of being independent, not only of any theory, but even of the existence of electromagnetic oscillations and undulations.

The apparatus is simple, and the special feature is shown in the accompanying figure. Two condensers, A and A′, in



every respect similar to each other, are formed each of a cylindrical lamp chimney coated within and without with tinfoil. Each of the two external armatures is divided into two annular parts, the one insulated from the other, namely, a and a_1, in the case of condenser A and a', a'_1, in condenser A′. The internal armatures are respectively connected up to the terminals of an induction coil, the wires being joined to the curved brass rods shown in the figure, which are in connection at one end with their respective armatures, and at the other end with the ball, b or b'. Between b and b' there is a gap of from 6 to 8 mm. From a and a' branch out towards each other two short horizontal pointed brass wires, p and p', and separated by a distance of 0·5 mm. To a_1 and a'_1 are respectively connected the copper wires, c and c', each 1,029 m. long, 3 mm. diameter, and terminating as shown in the figure at the points, p and p'. The dotted lines indicate the positions of damp threads, by means of which the two exterior armatures are connected electrically.

The discharge of the condensers is effected by a spark passing between b and b'. At this moment the charge on the external armatures is set free, and a difference of potential is suddenly set up between a and a' on the one part, and between a_1 and a'_1 on the other; the damp threads do not play any part at this moment, on account of the extreme rapidity of the phenomena. The armatures, a and a', are discharged by a spark passing between the points, p and p'; similarly the armatures, a_1 and a'_1, which are connected to the same points by the long wires, a_1, c, p; a'_1 c' p' are discharged by a spark between p and p', taking place subsequently to the first, since the disturbance has to travel a distance of 1,029 m. The interval of time between the first and second sparks, between the points, p and p', is the time taken by the disturbance to travel the distance along the copper wire, and to determine the speed of propagation it suffices to measure the interval, since the distance is known. Mons. Blondlot effected this by concentrating the light from the spark by means of a concave mirror movable around an axis parallel to p, p', and received on a vertical screen the doubled image of the spark. Given the speed at which the mirror is spun round, its distance from the screen, &c., the rest becomes a matter of simple calculation. A photographic plate may be substituted for the screen.

The results of fifteen experiments gave a mean speed of 296·4 kilometres per second. A set of experiments made on a wire, 1,821·4 m. long, gave a mean value for the speed of 298 kilometres per second. The approximate equality of these values, obtained on lines of different lengths, show that the movement of propagation is fairly uniform, and the numbers found are in accord with those previously obtained by another method by Mons. Blondlot.

INDIFFERENCE TO BOILER FIRING AND MANAGEMENT.

A recent number of *Cassier's Magazine* prints, from advance sheets, a paper by Mr. Ashworth on the above subject, which was to be read before the Engineer's Society of Western Pennsylvania. No apology is required for drawing attention to such a subject even in England, where, as a general thing, we believe attention to firing is given more thought than in America. The firing of an American locomotive as a rule is conducted upon very rough and tumble lines indeed, and the manner in which smoke rolls in dark volumes from their funnels would not fear comparison with a Mersey tug. Mr. Ashworth, as the result of over 20 years' observation, inclines to consider that the grade of service in the boiler-house has undergone a steady decline, or, at least, has made no advance, and he compares this with the continuous and steady improvement, during the same period, of the steam engine. Nor does he deny that the boiler has also been an object of great solicitude, though, for English conditions, we do not agree with him that the evolution from the plain cylinder type to the tubular, and onwards to the water-tube type, has been an upward evolution, so much as a throwing back to forms which a poverty of mechanical construction some years ago in shell boilers seemed to warrant. We are supported in this view by Mr. Le Van, a writer in the *American Machinist*, who states that the water-tube boiler is responsible for as many deaths and as much destruction of property as the shell boiler, and certainly the modern English type of boiler is as safe as any boiler ever made, even though its shell may have a diameter of 8 feet. When Mr. Ashworth states that there is an almost unanimous opinion that any man who can use a shovel will do to fire a boiler we will go some distance with him. Boiler firing is an art of itself which should be considered worthy of a better financial reward than is accorded it. A good fireman can so easily save his wages, as compared with a careless man, that a few extra shillings per week should not be begrudged him. One of the worst obstacles to economical steam generation is the item of coal money so commonly paid by coal *dealers* to the men in charge of the coal *burning*. The tendency of this premium for coal burned is not in the direction of economy, though we should not omit to say that we believe that there are many underpaid firemen who do not allow the coal premium to influence them in the least against their

employers' interests. Carelessness is, perhaps, chiefly to blame for wasted coal.

Why for example, when, from some accident or mischance a fireman finds the engine is taking more steam than the boiler is yielding, does he change his practice? Watch him and he will be seen to be careful to cover every portion of the fire-grate with fuel, where, as previously, he has allowed the two near corners of the grate to be slightly bare simply from neglect, the boiler, though less economical, having still given steam enough.

The slowing of the engine has called out the man's powers because, probably, he did not relish the heckling he would receive from the weaver girls, but the same degree of care the week through would save a lot of coal. Mr. Ashworth claims that a fireman should understand the elements of combustion. What does he mean by that? Given a fairly intelligent man with a will to economy, and the experience itself will teach him fifty times what any professor may know, quite apart from a knowledge of principles. The good fireman knows the effect of a certain practice though he cannot explain why, and all firemen know that the difficulty is too much air as a rule rather than too little.

There is just as much value in a knowledge of cause and effect as in a knowledge of principles. The professor with all his chemical knowledge could not keep steam many minutes against an unlettered skilled stoker. The smoke question is largely one of degree, and is certainly in England, at least, of daily lessening moment.

Our London fogs are coloured brown more by the fumes from ordinary fire-places than by smoke from factory chimneys, which often project above the fog, as may often be seen from a Yorkshire hillside, where the chimney tops project above an opaque sea of mist covering the house chimneys below, and imprisoning only the smoke from the lower sources. When a machine stoker is offered for sale, and the inducement held out that a skilled man is not required, we hold that that machine cannot succeed. Mechanical stokers require attention, and ought to be designed to save the mere rough labour of firing, but they are frequently heavy additions to the work, for the fireman is made to raise the coal to a double height into a hopper, and he is thoroughly dusted in doing so, and naturally disheartened and disgusted, and, of course, condemns the machine which should have had a coal elevator attached.

As Mr. Ashworth says, however, it is manifestly absurd to strain at great refinement in the so-called higher branches of steam engineering while neglecting the boiler furnace. Still we do not quite follow Mr. Ashworth when he classes with "other disqualifications" an inability to speak or understand a word of English. If his qualifications are all right an ignorance of any particular language is of little moment. While we would not discount the value of any knowledge for its own sake we may be permitted to doubt the utility of the art of polite letter writing in connection with the coal heap. Some of the best firemen we have known have been masters in most impolite arts, especially of language.

W. H. B.

"IMPULSE" AND "OSCILLATION."

Hertz's experimental work has served to illustrate the laws which Lord Kelvin and Clerk Maxwell have deduced from theory, and the commercial uses of the alternating dynamo machine have enabled recent investigators to show many well-known phenomena on a much larger scale than was possible when the old form of transformer, known as the Rhumkorf coil, was excited merely by batteries. There is danger, however, that, in the successful attempts to increase the scale of representation of the remarkable effects obtained by Prof. Crookes, the distinction between impulse and oscillation may become obscured.

An impulse is a sudden throb of a current, which is produced by a change of electromotive force. A generator, for instance, giving 400 alternations of current per second, will send 400 impulses through the outside circuit. If the well-known relation, $\frac{R^2}{L} < \frac{4}{C}$, holds in that circuit, a number of oscillations will follow each impulse. Messrs. Patterson and Arnold call attention in a recent paper (*American Journal of Science*, xlvi., 359) to this tendency to be obscure, with regard to such matters, which Tesla and other authorities have shown. They criticise this vagueness rather severely.

The number of impulses per second in a secondary coil is exactly the same as the number in the primary, but the number of oscillations in the secondary may be greater or less than those in the primary. Electrical oscillations cannot be transformed in the same way as electrical impulses. This statement, though capable of mathematical proof, has been studied by Messrs. Patterson and Arnold by the photographic method employed by Federsen, Lorenz, Trowbridge, and others, and the evidence obtained in this way bore out the truth of theoretical deductions, and showed conclusively that electrical oscillations in a primary current, in general, do not give rise to a higher number of oscillations in a secondary.

If a higher number of oscillations occur in a secondary circuit than exist in a primary circuit, there must be an air gap in this secondary circuit, and a suitable arrangement of condensers and self-induction. The oscillations which surge across such an air-gap in the secondary, in general have no relation to the oscillations across their gap in the primary circuit, unless the circuits are in resonance. Messrs. Patterson and Arnold's conclusion on this point is therefore this: The pilot spark of a primary circuit can give a series of impulses in a secondary—an increase of E.M.F. may result—which can force a spark across an air-gap in this secondary. The oscillations of this last-mentioned spark are not determined in general by the oscillations of the spark in the primary, and are dependent upon the arrangement of self-induction and capacity in the secondary circuit.

SOME ANOMALIES IN STEAM ENGINE DESIGN.

It is often difficult to secure exact evidence to show the uselessness, and, in fact, wastefulness, of striving after too high an efficiency in steam making and using. Such efforts often appear to be entirely oblivious to the hard practical fact that a steam engine itself absorbs inwardly a very fair proportion of the power that it generates.

Dr. E. D. Leavitt, an American, who has acquired eminence as a steam engineer, has a paper in the current issue of *Cassier's Magazine*, which draws attention to some practical facts. He instances two rotative pumping engines in Massachusetts, of equal pump horse-power, which he names A and B. They have the following dimensions:—

	Engine A.	Engine B.
Joint volume of H.P. and L.P. cylinders...	177	61
Piston speed	187	252
Duty per 100 lbs. coal	93 million foot pounds	$103\frac{8}{10}$ million

The piston movement per minute of the engine A was 30 cubic feet volume per pump horse-power, while that of engine B was only 15·7 cubic feet, from which it appears that with a piston capacity 1·91 times as large, and a cylinder volume 2·9 times, engine A was beaten by engine B, which did 11 per cent. more duty at the official test, and in 15 years actually did 36 per cent. more duty per coal unit consumed, despite the fact that it worked fewer hours.

Dr. Leavitt also brings forward other cases in confirmation of these views, showing that the Boston sewage engines performed a high duty with piston displacement of less than 20 feet, two trials giving almost exactly equal duty per coal unit. In one trial the I.H.P. was 251·5; in the other it was 290·2. For the greater horse-power, the evaporation in the boiler was less per pound of coal, and the feed water per horse-power was greater, but owing to the greater work put upon the engine the result was practically equal in duty per coal unit, the displacement volume per pump horse-power of the pistons, being 17·86 as against 20·06. The conclusion seems to be that for pumping engines a piston displacement of 15 cubic feet per pump horse-power is a sufficient allowance, and the lesson to be learned generally, is, that extravagance in design is fatal to that very economy which is sought after at so much expense.

As in each case the feed water per I.H.P. is only 14 lbs.

or less, it does not appear that the slowness of the piston movement has anything to do with the result in these Boston tests, or it might have been thought that no comparison could be drawn between pumping engines and engines for driving purposes. No doubt, in slow speed engines, the cylinder jackets have time to show their usefulness.—W. H. B.

JERRY WIRING FOR SHIPS.

It has ever been the lot of those who go down to the sea in the ships to face elemental dangers which make the bravest blanch with fear, but they are now threatened by a danger from within at once deadly and insidious.

Much has been done to ameliorate the condition of those who travel upon the deep. The "Ocean Tramp," no less than the Atlantic greyhound, is compelled by law to conform to conditions of safety. The "Coffin Ship" carrying to sea a doomed crew is happily a thing of the past, and inspections by Lloyds and supervision by the Board of Trade have tended to make the life of the sailor more human and the safety of passengers more assured. A steamship putting to sea with faulty boilers and weak engines is a rare event, and seldom does a vessel sail with a fuller complement of passengers than the law allows. The every-day life on board a passenger ship has been improved to a rare pitch of excellence, until it vies with—if it does not surpass—the comfort and luxury found on shore. Electricity has been a great factor in improving the conditions of life at sea. Time was when a night at sea meant misery lighted by foul oil lamps. We have exchanged this dim uncertain light for brilliant electric lamps, which, amid calm and storm burn steadily on, except when they burn the ship. Electric light never shows to greater advantage than on board ship; it is the one thing needful to make night time endurable, and to provide a gleam of comfort to the lot of storm-tossed seafarers. It must be confessed with pain, however, that an electric lighted ship too often carries potential evils, none the less deadly because unseen. Time alone is needed to convert this possibility of danger into an absolute certainty. The lives of hundreds, nay, of thousands, are at the present moment in imminent jeopardy, because the vessels in which they are journeying are as unsafe as the most decrepit old junk that ever left port. The jerry wirer has contrived to convert substantial seaworthy boats into highly dangerous vessels. These remarks do not apply simply to cargo boats and small passenger vessels; it is an undeniable fact that some of the finest boats which leave these shores are wired in a most scandalous fashion. Not only is the workmanship bad, but the material used is of the rottenest description, and nothing short of the marvellous can possibly prevent fires. The jerry wirer is rampant in this year of grace, 1894, and shipowners, heedless and ignorant of the effects of bad work, encourage this abandoned wretch to put in materials which would disgrace a marine store. We know not whom to blame the most. It is impossible to locate the entire blame on the shipowner, for presumably he is not cognisant of the responsibility he incurs when sending a badly wired ship to sea.

The really culpable person is the electrical engineer, undertaker, jerry wirer, or by whatever name he styles himself; when he carries out his jerry wiring, he prepares, in reality, a ghastly death trap for his fellow men. To appeal to him would be useless. He owes his existence to the extraordinary loose conditions which prevail, and the advent of a proper supervision would be his death warrant. In attacking the jerry wirer we are not tilting at windmills; we are making an onslaught upon a baneful system which demands immediate and vigorous remedial measures. We have selected from a large collection a few of his efforts in the art of wiring, joint making, &c., and we think they will provide a useful lesson.

We illustrate some samples taken from vessels at different dates; they have not been doctored for the purpose of creating a sensation, but are "living" specimens, many of them taken from well-known liners. Fig. 1 shows a specimen of jointing as practised by the jerry wirer. An attempt has been made to join two branch wires (19/16s) to a main cable of 19/14, and as will be seen, the attempt is a dismal failure; the wires have been simply twisted together, and are wholly innocent of solder. This high class joint, when finished, had been simply wrapped with tape. Fig. 2 is a novel and somewhat slovenly manner of connecting three lamps to a branch main; comment is unnecessary. It is difficult to decide whether the two eye-joints shown in fig. 3 were made at sea by some deft fingered sailor, or whether they were done by a jerry wirer in the guise of a bellhanger. The evidence which we have collected is suggestive of the latter. The joint shown at the top of the figure was taken from a steamship of first-class rating. Fig. 4 illustrates electrolytic action in a very advanced state on an electric light cable, 19 strands being reduced to 5. This is an exceedingly common form of deterioration, and usually excites no apprehension. Common jute is the insulating material used on this particular sample. No mechanical protection whatever was provided for this cable, which was simply nailed to the ship.

Fig. 1.

Fig. 2.

We have a wooden switch, shown in fig. 5, which came neither out of the Ark, nor out of the "wooden walls of Old England." It was found on board a modern ship, and is a

Fig. 3.

grotesque example of latter day improvements. The contact piece is of brass, and works stiffly on the wood work. There is evidence of charring, due to apparent heating of the con-

Fig. 4.

tact piece. This switch, it may be mentioned, carried the fuse wire inside, and the whole was considered, no doubt, a neat and useful combination. Wooden switches were much

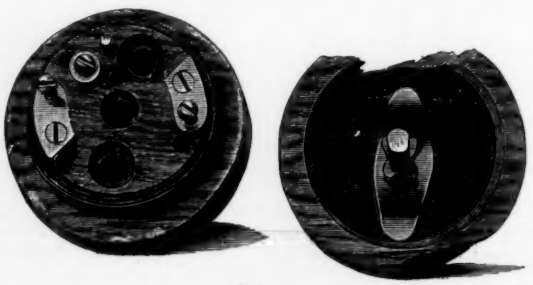


Fig. 5.

affected in the youthful days of electric lighting, but it is startling to find them still in use.

Simultaneously with our enquiries into ship wiring, we received a letter from Prof. Jamieson, enclosing some specimens of electric joints. Fig. 6 illustrates three of these. We give his letter in full, because it helps our contention that jerry work is more widespread than is imagined.

Electrical Engineering Laboratory,
The Glasgow and West of Scotland Technical College,
Glasgow, *February 12th*, 1894.

Dear Sirs,—I send you by this post six specimens of electric light wire joints, which were recently cut out of a ship's installation by one of my old students. Not one of these joints has been soldered. I have seldom come across more unsafe workmanship, or miserably bad insulating material. During last summer I happened to travel on two large steamers where the wiring had evidently been done by bellhangers unacquainted with fire insurance rules. Is it not high time that Lloyds Register of British and Foreign Shipping, instead of issuing a set of "*Suggestions*" (see page 555 of Munro & Jamieson's Pocket Book Edit. 10) for the use of electric light on board vessels, should call them Rules, and appoint inspectors to see that these Rules are thoroughly carried out?

Andrew Jamieson.

We have only to add to this letter that the middle specimen was actually found joined up in circuit with 15 lamps, each of 16 C.P.

Fig. 6.

Our own investigations have revealed practices which equal, if they do not surpass, Prof. Jamieson's experience. On one ship it was discovered that the casing was torn away in one place, in such a way as to expose a bare joint. The engineer of the vessel was asked if there were many like that. Oh, yes! Most of the joints were not taped and never had been! Yet no concern was felt; it was a matter that interested nobody, and no attempt was made to remedy the state of things. In another instance iron pipes were used as a protection for the cables. The engineer, upon being asked whether the pipes were waterproof, in a satirical manner replied that they were not even coal proof! The electric light on one ship failed at sea. On arrival at port tests were made to discover the fault; it was found that the casing containing the wires had been carried across the hold in such a manner, that when a cargo was shipped, the casing and wires were snapped in two; the ends of the wire stuck out in the most ugly manner, and little was required to make a short circuit. It is when using fuse wires that the jerry wirer's latent genius for evil is pre-eminent. The tale of a lighting circuit protecting a fuse wire is old, but it does not exaggerate the proclivities of the lighting contractor. The cases that have come before our notice are numerous. A representative one is that of a fuse wire protecting four 16-C.P. lamps on a 50-volt circuit; upon testing this wire it took 120 amperes to fuse it. If it were necessary, we could multiply instances similar to the foregoing, but sufficient has been said to show the hideousness of much of the present ship wiring. Things have reached such a pass that respectable firms refuse to tender for ship wiring on the grounds that good work cannot be done cheaply, and it is the cheap work which is generally selected. To all intents and purposes, therefore, the jerry wirer has a monopoly, and unless stringent measures are at once adopted, his wretched work will be on every ship. The attitude taken up by Lloyds in this most important matter is extraordinarily puerile. In a hesitating manner they offer a set of amateurish suggestions which are unheeded by the contractor. Our recent investigations call for the appointment of efficient surveyors to prevent this reckless trifling with valuable property. To the Board of Trade, however, must be relegated the power to supervise on behalf

of the public. Travelling by sea has, through the action of the jerry wirer, become so highly dangerous, that prohibition and punishment are urgently needed.

STORAGE BATTERIES.

Mr. C. O. Mailloux, in the second part of his article, "The use of Storage Batteries in Electric Generating Stations for Utilising and Regulating Powers" (*Western Electrician*), dwells upon the great advantages which may be derived from a properly selected storage battery in a central station.

Not the least beneficial result is the steadying influence exerted on the potential by even a battery with a relatively small output, as compared with the total current. While the potential shows considerable irregularity when the current is supplied from the dynamo alone, the pressure becomes absolutely constant as soon as the batteries supplement the dynamos, the current derived from the batteries being not more than between 8 and 15 per cent. of the total output.

It is fully recognised that the success obtained with storage batteries is owing to a thorough appreciation of the requirements and conditions of every individual case, and the strict limitation of the work to be expected from them. With a more recent type of improved Planté accumulator, with which the author of the above paper has evidently had no opportunity to make himself acquainted, this limitation need not be so strictly adhered to.

Long life and high efficiency are proclaimed as the essentials of a successful battery, an increased first cost being a minor consideration.

That Planté batteries are, as a rule, of lower capacity than the pasted cells, is a fallacy which we hoped to have seen exploded ere now. Not only do they allow heavier rates of charge and discharge, an advantage which is conceded to them by the author, but the capacity of a type, well known and greatly appreciated in England, compares very favourably with any pasted type, more especially at high discharge rates.

Actual data relative to central station work prove that the efficiency of the storage batteries is satisfactory, varying in the stations under observation between 78 and 85 per cent., and as on the basis of past experience manufacturers give a 10 years' maintenance guarantee at the rate of about 5 per cent. per annum, the depreciation is a fixed and moderate item.

On asking the question, "Where are storage batteries to be used?" the only possible and reasonable answer we may expect, and which the author gives is, "Where their use is of advantage." We are further informed that this may consist in a saving of initial cost of power or of labour, or in the securing of an increased revenue. In cases where the load curve is steep, its maximum height covering only a short period, it will generally be cheaper to use a smaller plant and a storage battery, which serves the double purpose of taking part of the dynamo output during the time of light load, and supplementing the machinery while the heavy load is on.

A saving in the cost of conductors can be effected by erecting sub-stations near the centre of consumption and charging these at a uniform rate during convenient hours, instead of supplying the current direct as it is required.

The saving of labour is an important consideration. With accumulators the station can be locked up and the current supplied entirely by the storage batteries without any attendance for many hours each day.

The gain from increased revenue is effected in cases where the supply of power is continuous but limited, usually water power, but this may apply also to the case of gas engines.

The concluding paragraph deals with the intended application of storage batteries to electric railway power stations, the object being the same as in lighting stations, viz., economy, especially the saving in initial cost and in power.

It is disappointing to learn that of all the street railway managers who were approached, not one was willing to try accumulators, so great is the disrepute into which storage batteries have fallen in America. We hope that this failure was due to the railway managers having been requested to try the experiment at their own risk. If so, would it not be fairer and more to the purpose if the manufacturers of storage batteries would take all the expenses and risks, if any, of such a trial upon themselves, in order to gain that experience which is necessary both for their own guidance and for that of naturally sceptical street railway managers?

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND INDIA, ITS PRESENT CONDITION AND FUTURE DEVELOPMENT.*

By E. O. WALKER, C.I.E. (Late of the Indian Telegraph Department.)

When communication between England and India was first opened, the unit of charge was a message of 20 words for £5, or at the rate of 5s. per word. In 1876 the minimum chargeable unit was reduced from 10 words to one word, containing not more than 10 letters, but the charge was fixed at 4s. 7d. This was a distinct improvement, since a message, consisting of as few as three chargeable words, could now be sent. Evidently the public appreciated the alteration, for in the year 1876-77, although the average value of each message had decreased 12 per cent., still private senders despatched 22·4 per cent. more messages, and the gross value was increased by 5·3 per cent. In 1887 the charge was 4s. 2d. per word, and at the present time from England to India the rate is 4s., *viâ* Suez and Teheran, and 3s. 8d. *via* Turkey. From India to England the corresponding rates are Rs. 3/4/- and Rs. 2/15/-. The charges in India are altered from time to time by the Government, to prevent loss by exchange, since payment must be made to the companies in gold, a proceeding which is unwelcome to the commercial community, and which, when applied in South America, was resented, and had to be abandoned.

In 1868, the Indo-European Department and the Turkish line earned something like £187,200. The opening of the Suez route at once diverted a large portion of the traffic, and it also stimulated it. The Eastern Telegraph Company has never paid less than 5 per cent., and often more than 6 per cent. The Indo-European Company, although for a few years unremunerative, was able to pay 5 per cent. in 1874, has not paid less than 8 per cent. since 1880, and as much as 12 per cent., and in the past five years often 10 per cent. In 1891-92, 92·4 per cent. of the traffic went *viâ* Teheran, and 7·6 per cent. *viâ* Turkey; but this is fully accounted for by the fact that the mean rate of transmission in that year by the former route was one hour, and by the latter sixteen hours. It may be remarked in this contrast that the Indo-European Department, controlling the lines from Kurachi to Teheran, has been of late years only able to show a credit balance. In 1891-92, the nett profit was 1·4 per cent. This is due to the heavy outlay on the Persian Gulf cable, and this is an important factor in determining the telegraphic rate to India. In 1878, an agreement was effected between the Eastern and the Indo-European companies and the Indian Government for a "joint purse," based on the actual traffics each line dealt with. By this arrangement the Eastern Company gets 60·39 per cent. of the revenue for Indian traffic, and the other company, with the Indo-European Department, 39·61 per cent.; for trans-Indian, or Far East traffic, the figures are 80·53 and 19·47 per cent. respectively. The actual percentages of traffic since carried differ from these figures. The averages, from 1878 to 1892, for Indian messages are 56·5 per cent., *viâ* Suez, and 43·5, *viâ* Teheran.

The amounts earned and paid into the "joint purse," on account of Indo-European messages for some of the years, from 1878 to 1892, are as follows:—

1878-79	...	...	...	...	...	£310,009
1881-82	...	...	...	...	...	360,011
1888-89	...	...	...	...	...	335,257
1891-92	...	...	...	...	...	360,098

In 1891-92, the share of the Eastern Telegraph Company was £217,465; of the Indo-European Company, £80,445; and of the Indo-European Department £62,188. If the overland lines had retained all they earned in that year, their shares would have been £106,488 and £81,760 respectively. All administrations concerned earned something more for Far East traffic, with the Straits Settlements, China, Australia, New Zealand, &c., the share of the Eastern Telegraph Company on this account being £229,045, of the Indo-European Company, £34,218, and of the Indo-European Department, £21,164. The dividends paid by the first two were at the rate of 6½ and 10 per cent. respectively.

The capital, including ordinary, preference, and debenture stock of the Eastern Telegraph Company was, in 1891-92, £6,100,000, and its reserve fund £442,014. The capital of the Indo-European Telegraph Company remained at £425,000, and its reserve was £172,839. These last figures, coupled with those of the excellent dividends distributed, and also the admirable service afforded by the company, will show what land lines can do when well administered. The capital expenditure by the Indo-European Department, up to the year under review, was Rx. 1,150,000.

* Abstract of paper read before the Indian Section of the Society of Arts, on Thursday, February 8th.

The figures given include the revenue derived from Continental messages as well as those of the United Kingdom. Supposing the number of telegrams to be proportional to the whole value of the trade, then, in 1892, one-quarter would have been sent between India and the Continent, and three-quarters to or from the United Kingdom. Thus out of the revenue for 1891—92 for Indian traffic, £270,000 was approximately contributed by Anglo-Indian and £90,000 by Indo-Continental messages.

Now, I have little doubt that it will surprise most to know that the total amount paid for telegrams between India and the United Kingdom in 1891-92, namely, £270,000, was only about quarter per cent. of the value of the total trade, Rx. 95,222,155. I attribute this unnatural restriction of traffic solely to the high rate which prevails. Small traders cannot, on account of the expense, use the wires, and I think my friends in India will bear me out in the statement that foreign telegrams are, as a matter of fact, sent by the comparatively few wealthy firms. Private persons, owing to the cost, rarely communicate between England and India by telegraph.

Now the last 20 years have witnessed an extraordinary extension of inland telegraphs in both countries. Speaking from experience in India, I can say that they have largely aided in the transport of produce, and in bringing up-country merchants into connection with distant markets, with which formerly communication was difficult and slow. In order to make a profit at the present day it is often necessary that transactions should be effected quickly, and whenever telegrams are made cheap it has been found that they are readily used for this purpose. Moreover, native firms are learning to deal direct with European manufacturers. Could they communicate by telegraph, at a low charge, there can be no doubt that the trades concerned would receive a stimulus. It is, perhaps, open to doubt, whether it would be a public benefit to afford cheaper means than exist at present, by which the Secretary of State could speak to the Viceroy of India. There would, however, be a large reduction in the present considerable telegraph bills of the two Governments; and they should be, equally with the general public, interested in lowering foreign telegraph rates.

The inland telegraph traffic in India, in the last 20 years, has increased from 684,388 to 3,441,637 messages; while that exchanged between that country and Europe has increased from 50,462 to 193,782 messages, by all routes. This number, it must be noted, include all Indo-European official, commercial, press, and domestic messages. Thus, setting the Continental traffic aside, India and England only exchange about 465 messages per working day. This fact, when compared with the volume of their mutual trade, and with the enormous political interests common to both countries, speaks for itself.

What amount of traffic could be easily carried by the Indo-European and Eastern Companies with their existing lines, should the introduction of a reduced rate largely augment the number of telegrams? I will suppose that two out of the three cables are used for through traffic to India, and that there are two through wires *via* Teheran. These four working circuits are capable of carrying at least each 15 words per minute, or say, to give you a better idea of their capacity, one message per minute. In 24 hours a traffic of 5,760 messages could be dealt with, or five times what passes at present between Europe and the East. But by duplexing, without increasing the capital outlay by more than a small sum—£15,000 in the case of the Eastern Company's cables—the carrying capacity of the circuits could be almost doubled. This would afford means of now dealing, in conjunction with the Indo-European Company, with over 7,000 messages daily. The lines of the latter are not, I believe, at present using the duplex system, but there is no difficulty in applying it, and increasing largely the ability of the company to cope with a large traffic. Then the Turkish route, in capable hands, can be made as serviceable as the others. It is quite possible that owing to telegrams on business being despatched during working hours, that the bulk of the traffic will be confined to part of the day only, and, at the same time, desirable that it should not be allowed to accumulate. Supposing even that it is dealt with between 11 a.m., London time (*i.e.*, 4 p.m., Indian time), and midnight. Then the present circuits duplexed could carry over 4,000 messages in that interval, with no excessive delay on each. Were all these Anglo-Indian messages, at a rate of two rupees, or 2s. 6d. per word, would produce a revenue of £6,850 per day, taking each message to consist of 13·7 words, as was the average for private messages in 1891-92, or over £2,000,000 for the year of 300 working days, which, after deducting the Indian Government share, would leave something like £1,750,000 to be divided between the companies, against £650,000 at present. Of course I am aware that even at a rate of 2s. 6d., the traffic is not likely to increase with so great a bound, but there is little reason to doubt that with India, as well as the Far East, it will be worked up to in 20 years, if charges are substantially lowered at intervals in that period.

With a growing foreign trade, the revenue in 1891-92, from Indo-European traffic, was about the same as that for 1881-82—about £360,000. Some will attribute this to the process of condensation, or codification, which has been going on, that is, the use of letter or word cipher. No doubt this has unfavourably affected revenues, but then it is a science fostered by high tariffs. I am prone to think that the want of progress is rather due to the fact that there has been practically little reduction in cost per word for 20 years. I venture to assert that, in existing circumstances, looking at the dividends paid, the substantial reserves accumulated, the reduced cost of cables, as compared with 20 years ago, and at the fact that the lines can carry a much larger traffic than they do, the public has a claim, and the companies and the Governments of India and this country have an interest in making Anglo-Indian telegrams cheaper. I would add that the Indian public ought to be relieved of fluctuating charges for the messages, made to depend upon the course of exchange. The charge can, and should be reduced by 6d. yearly, until the present rate—4s.—is lowered to 2s. 6d. This course would obviate any serious falling off in receipts. No guarantee by Government, nor by the commercial communities concerned, should be required to insure the companies against loss in taking this step. Their present position is sufficiently strong financially to admit of their incurring the risk.

I have recently been favoured with the opinion of the Madras Chamber of Commerce regarding the present tariff. It "considers that the present Indian rate of Rs. 3 4a. per word is far too high, and that it would not be unreasonable to ask for a fixed rupee rate of Rs. 2 4a., considering that a large proportion of the telegraph company's (*i.e.*, the Eastern Company's) expenditure is in rupees. The Chamber does not view with favour the present system of a tariff fluctuating with exchange." This is the opinion of many others connected with trade in India, and anyone who may care to inquire will, I think, discover that there is at the present time a positive reluctance to resort to the telegraph, instead of the hourly use of it becoming habitual, as a low tariff would bring about.

But, in my opinion, what is essential to the introduction of a permanently low charge is the extension of the overland systems of telegraphs. I desire to point out that there are three links to be completed in these systems, which would, with a properly organised service under central control, in connection with the European lines, certainly afford means to India and England of exchanging correspondence far more cheaply than at present. They are as follows:—Shiraz to Jask, in Persia, 575 miles, a telegraph line by this route will, at a cost of £35,000, complete the overhead wire from London to Calcutta, with the exception of the short cable across the channel. This amount is less than the cost of maintenance of the Persian Gulf cables for two years. When such a line was well and strongly established, the cables from Kurachi to Gwadur could be taken up and used elsewhere. In the end, even if the cables were abandoned, there would be a positive saving to the Government of India on the cost of maintenance, and of some of the telegraph station establishments on the Gulf, for only two repeating offices would be required between Kurachi and Teheran. A new trunk line from England to India, *via* the Continent, Russia, and Persia, with the necessary offices, would not, in the light of the experience we now have, and at the present chief prices of materials, cost more than £450,000. The Home and Indian Governments might possibly find it economical to construct such a line, primarily for their own correspondence.

The period of the Indo-European Company's concession from Prussia, Russia, and Persia, and the convention existing between India and Persia, will expire in 1895, and a favourable opportunity thus occurs of revising arrangements with regard to overland communication with India.

The second link, which it is important to complete, is that from Mashad to Herat, and thence to Kandahar and Quetta. From Teheran to Mashad, 562 miles, there is now a telegraph line belonging to the Persian Government, but maintained by the Indo-European Department. The interruptions of this line, mostly occasioned by camels knocking down the posts, are excessive, but are becoming less. It is known by experience that a line can be made strong enough to obviate such accidents. Mashad sent about 2,000 messages to the Persian Gulf stations in the year 1891-92, a fact which shows that when these out-of-the-way places are connected by telegraph with trade outlets, the local traffic is an important item in estimating revenue. From Mashad to Herat is about 240 miles. Mr. Curzon informs me that the road is very much travelled, and that neither itinerants nor inhabitants would be likely to take exception to telegraph poles and wires. From Herat to Quetta, *via* Kandahar, some 500 miles, there are no physical difficulties; and there is every likelihood that, before long, the present Amir will look favourably upon the introduction of the telegraph, equally with other applications of modern science, into his dominions. At Quetta, the lines of the Indian Telegraph Department are connected with the Punjab and with Kurachi. I shall be told that the telegraph work in Afghanistan is perilous. No doubt at first it will be. The telegraph operations in Burma have been difficult and hazardous, but most of the lines are now permanent and reliable.

In the Afghan war, Mr. Luke, of the Indian Telegraphs, managed to keep the wire open from Kabul to Peshawur, and Mr. Pitman, at Kandahar, held communication with Kurachi. The difficulties now to be encountered, with a Government favourable to the enterprise, would be comparatively light.

There remains one more important gap to be filled up in the Asiatic systems of telegraphs, namely, that from Merv to Herat *via* Penjdeh. These are joined by a road about 240 miles in length along the valley of the Murghab. A telegraph line here will, when Herat is connected to Quetta, unite India with the present Russian Asiatic telegraphs that lead to Europe by the Caspian Sea. A second trunk line through European Russia, *via* Merv and Herat, and so to India, will afford a valuable alternative route in time of peace, and by this, in combination with the line of the Indo-European Company, or another through the south of Russia and Persia, the whole of the traffic between Europe and the East could be carried. Such lines would propably earn much from local traffic. The cost, not more than a million sterling for the two separate lines, would admit of messages passing between England and India at a shilling per word, with provision yet for interest, at the rate of 8 per cent. on the capital.

It is essential to the success of the working of long lines passing through foreign territories that they should be administered by one responsible directorate; and existing circumstances point to the Home and Indian Governments, as well as the company that has already achieved such good results, as the authorities best qualified to promote telegraphic enterprise in the localities I have indicated. No time should be lost in acquiring the rights to do so. By diplomacy and the timely grant of small subsidies, the exclusive appropriation by these routes of certain wires for an international service could be secured.

THE BOARD OF TRADE REGULATIONS ON ELECTRIC TRACTION.

On Wednesday morning a meeting was held at the Board of Trade offices, Whitehall, under the presidency of Sir Courtenay Boyle, C.B., to discuss the objections which had been received from various bodies interested in electric traction and its effects, to the draft regulations prepared by the Board of Trade in accordance with the recommendations of the Joint Committee, which sat last year to consider the conditions on which electric traction should be authorised. The other Board of Trade officials were Major Cardew, Sir Thomas Bloomfield, and Mr. Hopwood. The representatives were as follows: Messrs. A. Siemens, R. E. Crompton, Major-General C. E. Webber, C.B., and Mr. W. M. Mordey, Institute of Electrical Engineers; Messrs. Gaine, Sinclair, and Winterbotham, National Telephone Company; Mr. J. Clifton Robinson, Imperial Tramways Company; Messrs. Monier, Williams, Field, and Foulger, Gas Light and Coke Company; Sir Frederick Bramwell and Mr. Collins, Associated Metropolitan Water Companies; Messrs. J. Swinburne, Percy Sellon, Emile Garcke, J. W. Winslow, and S. Sellon, Traction Committee, London Chamber of Commerce; Messrs. J. Kincaid, Manville, Bristol, Birmingham Central and South Staffordshire Tramways; Sir H. Oakley, Messrs. Lambert, Langdon, and Aspinall, Association of Railway Companies; Mr. Pritchard and Dr. Fleming, Association of Municipal Corporations; Messrs. W. J. Carruthers-Wain, A. P. Smith, John Waugh, John Hesketh, J. Hewson, and J. G. B. Elliot, Tramways Institute.

The Chairman said they were there that day to discuss regulations in clauses which were in certain Bills, and which would probably be inserted in all Bills as model clauses. They had to settle the regulations, as they would probably be inserted in all Bills to be of general application. The consequence was that they were to discuss practically what he supposed would be regulations of general application in all instances of traction by continuous current. The Board of Trade secured the appointment of a joint committee last year, and it thought these important questions should be finally settled by Parliament itself. But Parliament had decided that upon the Board of Trade should devolve the duty of making regulations. Consequently that day they had the duty imposed on them of settling those questions.

The London Chamber of Commerce asked if definition 6 in the draft regulation was intended to apply to telegraphic, telephonic and railway signalling currents.

The Chairman said the word "currents" might, through the regulations, be applied to traction only.

On regulation 3, which read: "Where any rails on which cars run, or any conductors laid between such rails form any part of a return, such part may be uninsulated. All other returns, or parts of a return, shall be insulated." The Institute of Electrical Engineers moved that after the word "between," the words "or contiguous to" should be inserted; after "uninsulated" the words "but the supports of all overhead wires, whether live or return, shall be electrically connected to the return circuit," and after "insulated" the words "unless of such sectional area as shall satisfy the Board of Trade."

The Chairman promised to consider the matters.

An alteration to Regulation 4 was proposed by the National Telephone Company. The regulation read: "When any uninsulated conductor laid between the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100 feet, by means of copper strips having a sectional area of, at least, one-sixteenth of a square inch, or by other means of equal conductivity."

Mr. Winterbotham said the Telephone Company was satisfied that induction, and not leakage, was the main cause of disturbance, and that that disturbance would be minimised by requiring "the return," whether insulated or uninsulated, to be placed parallel, and as near as may be to the line. Regulation 13 provided for that where the return was insulated, whether run overhead or underground. The National Telephone Company was advised that there was no reason (either electrical, engineering, or financial) why a similar regulation should not apply to the case of an uninsulated return. Obviously that was simple, where the line and return were both underground, and where the line was overhead, it was easy also to carry the *return* overhead and within a reasonable distance of the line, connecting the return at each post with the rails by means of suitable copper conductors. In most cases that return might suitably be carried on the poles which carry the line from which the feeders are supplied with energy. Regulation 4 provided for an electrical connection between an uninsulated conductor laid between the rails and forming part of the return and the rails themselves, at distances not exceeding 100 feet. It was suggested that that regulation should be modified, so as to provide for the same electrical connection with an uninsulated return carried overhead in the manner suggested above, and that the connections should be not more than 50 feet apart, or if the distance of 100 feet is maintained that the connections should be alternately to each rail, so that there should be a connection between one or other of the rails and the return every 50 feet. If they struck out the word "insulated" in Regulation 13 and have the words "laid between the rails" in Regulation 4 struck out, that would meet the case.

After some discussion, the Chairman said he would not decide the matter that day.

On Regulation 6, which dealt with the connection of the return currents with water pipes, it was suggested by the water companies that no connection with a water pipe within 6 feet of a gas pipe should be allowed without the consent of the owners of the gas pipe.

Major Cardew suggested that paragraph 4 should read, "No portion of either earth connection shall be placed within 6 feet of any pipe of less than 3 inches in diameter unless with the consent of the owner, except a main for water supply; such consent not to be unreasonably withheld."

This was adopted.

The associated railway companies further suggested that an uniform system of joining up the generators be observed, whether the return be insulated or not, the object of that being to enable the block instruments to be joined up in such a manner that the traction current should produce the "Train on Line" signal, and not the "Line Clear" signal.

Sir Henry Oakley said that what he wished to do was to take care, as far as possible, that railway companies should have the right, before any provisional order was passed for the construction of a tram-road, to appear and get the best protection they could, either from the Board of Trade or a Parliamentary Committee.

Major-General Webber said the protection of block signals entirely laid with the railway companies.

The Chairman said it was the desire of the Board of Trade to give every protection to the railway companies.

The conference adjourned till Friday.

CORRESPONDENCE.

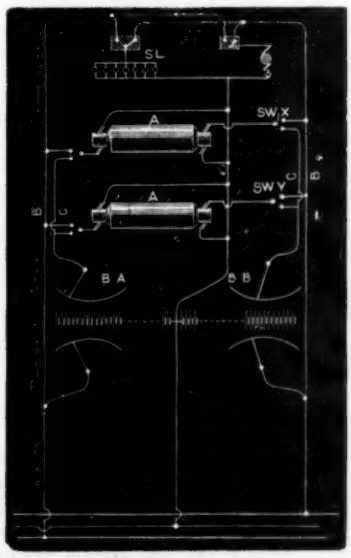
Balancing in a Three-Wire Station with only One Machine Running.

It is surmised that the electrical arrangements of Burnley Electric Light Supply Station are open to comment, and that a question on the above subject may bring forth some useful information. In a three-wire station of this size, what practical objections are there to arranging the electrical apparatus as here shown?

The generators shown are shunt-wound, the shunts being connected across the outside terminals of dynamo and not connected to the balancing wire at all. Variable shunt resistances mounted on switchboard in the usual way.

The armatures have each two windings and two commutators, constructed for an output of 200 ampères from each commutator with its half of the winding. Making a total of 400 ampères at 250 volts—which is practically the "Compensator" described in the account of the Burnley station.

The lamps and motor shown at the top of the sketch are "near by" lamps, also the station motors, &c., which are arranged with two or more two-way switches, so that they can be connected between the balancing wire and either one or other of the feeders. We will now suppose that the generators are connected to the bus bars, and the positive feeder ammeter reads 400, negative 300, balancing wire 100, and that the motor working the mechanical stoker, &c., and the station lamps together total up 30 ampères, and are connected to the positive or heavily loaded side of the circuit.



S L, Station lamps; S W X, Switch; S W Y, Switch; A, Armature; C, Charging bar; B, Bus bar; B A, Battery A; B B, Battery B.

The engineer switches them over to the negative, which takes 20 ampères off the heavily loaded side of the armature, and loads up the other side to the same amount; thus leaving 40 ampères to be balanced by taking 20 ampères out of

battery A, and charging battery B to the same amount, and if, during the whole evening, the feeders should remain the same or get further still out of balance, then, on the following day, the battery A will require longer charging than B, which is simply done by charging from the charging bars until B is "full," then disconnect switch, X or Y, as the case may be, according to which generator is at work. Battery A is then charging by itself.

It is easy to see that by this arrangement, also, either battery can be charged independently of the other, and at any desired rate.

It is obvious that unloading the heavy side, and loading up the empty side *at the station* will not get over the difference in the potential drop between the positive and negative feeders from the streets to the station, but by regulating the battery switches, and observing the voltmeter connected by pilot wires to the feeding points it can be compensated. This plan is clearly simpler than using a "compensator," inasmuch as a 4-ton machine, using 7 or 8 B.T. units per day and several gallons of oil per week, is replaced by an extra commutator.

Perhaps some of your readers are acquainted with a still simpler method of working a small three-wire station with one machine and battery at work, or can see a drawback to this one, in which case I would be glad to have it pointed out.

A. H. Gibson.

February 15th, 1894.

A Main Consideration.

Answering Mr. Mavor's letter criticising your leader headed "A Main Consideration," it is generally supposed that a preacher who causes the individuals comprising his audience to take his praise, or blame, or warning, as applying only to themselves, is paid the highest compliment. On this ground, please convey my thanks to Mr. Mavor.

The Writer of the Article.

Disturbances in Dynamos.

I notice several mistakes in an article appearing in your issue of the 16th. For instance, paragraph 41. I have reason to believe that most, if not all, makers of dynamos with more than one magnet coil couple up the shunt winding in one length, *i.e.*, in series with one another and *not in parallel*, as only in the latter case would the author's reasoning apply, as the current flowing, therefore the heating effect would be the same in each coil. The author's remarks would, perhaps, apply to low voltage machines with two or more coils (shunt) coupled up in parallel; but I gather from the article that lighting machines only are being dealt with.

With regard to the footnote, it is even more absurd, as he says "When the exciting current is too strong, in a series dynamo, it must be reduced," &c. Anyone with the slightest experience in designing and making a dynamo must see the absurdity of this advice, where efficiency seems not worthy of consideration.

Paragraph 42 is so ridiculous that the mistake must show itself to anyone worthy of the name of electrical engineer.

I could, if necessary, point out almost a dozen similar mistakes, and I think that, altogether, the article is unworthy a place in your valuable paper.

Thos. G. Slater.

February 17th, 1894.

Direct-Driving versus Rope-Driving.

Mr. Pink's letter scarcely illuminates this question, except as showing that Mr. Hammond has disciples among those who have worked his stations, which is, of course, natural. The facts about the Madrid station* may be interesting, but they offer no basis for comparison, and the question whether the steam dynamos of "any single-acting direct-driving station of six 100-unit plants" can be kept in order by "one fitter and labourer," will only provoke a smile from other station engineers, who, however, can hardly be expected to intervene in a question which, for the great majority of them, is dead beyond resuscitation.

No one disputes that slow-speed, rope-driving engines give "reliability of running." To condemn them it is not necessary to prove them bad from every point of view. One may admit that they are very good engines—only others are better; that is, better on most points, and equal in others, amongst which "reliability" may be numbered. If Mr. Pink wishes to make a point of the doubtless reliable running of the Madrid rope-driving engines, he must offer evidence that the single-acting direct-coupled engines now generally used run less reliably.

Mr. Pink is wholly wrong in what he supposes to be the effect of imperfect synchronising upon direct-coupled engines. Without following his reasoning step by step, it is only necessary to say that there has *never* been a case, so far as we have heard (and such cases would hardly escape us), where a Willans engine has suffered any injury whatever, however small, from a sudden load thrown upon it; the mere supposition is, in fact, absurd to anyone who really understands the problem. The "very heavy strain put on the crankshafts by a sudden increase of load" is imaginary. If Mr. Pink has really heard of "strained crankshafts, broken coupling bolts, &c., through heavy load being thrown on this type of engine suddenly," we shall feel much obliged for further information. We can give none, although Mr. Pink tries to help us by citing the stations at Manchester Square, Bankside, and Bristol, as examples of the evils he imagines. At Manchester Square (where the engines have been at work some four years), they have had broken crankshafts, for reasons, some of which apply to that particular plant alone (but we have heard they are now removed), while none apply to any Willans engines made during the last two or three years. In any case, sudden loads through imperfect synchronising have nothing to do with the question, for, so far as we know, the machines *are not run in parallel* at Manchester Square. As for Bristol, all we have heard is that the parallel running there with the Willans engines is singularly easy and perfect, while Bankside is an extremely bad choice for Mr. Pink. Not only have the Willans engines there run, so far as we can learn, without any hitch of any kind whatever, but they indirectly contradict Mr. Pink's one plausible contention—that there is merit in the slight elasticity of the ropes. The Bankside sets were arranged with two engines coupled to each dynamo, by couplings which could be used either as rigid connections, or to act through magnetic pull, so that either engine could be instantly connected or disconnected without stopping the dynamo; the magnetic connection gave a slight elasticity, probably an angular movement of at most one inch on a radius of about 2 feet 6 inches. We are informed that with rigid coupling the parallel running was found to be *better* than when this very slight elasticity was permitted. At Bristol the sets are coupled rigidly, and there, as stated above, the running is perfect, at least we have received orders lately on behalf of the Bristol authority for two more large engines (360 I.H.P. each) direct-coupled to alternators.

Mr. Pink must offer more than "flat contradiction" to the statement that rope-driving for dynamos is "obsolete and inefficient."

The people for whom the question should have a real interest are the ratepayers of Islington. It may be well to erect a monument to a dead cause, but its admirers should be at the cost of it, not the public. For all time Islington is to pay more per unit for its coal, more for its oil, more for its attendance, more for its repairs, as well as more for its plant, and much more for its buildings, because it chooses to use horizontal engines and belt-driving.

With St. Pancras on one side of them, with Willans engines coupled direct to continuous current machines, and Hampstead on the other, with Willans engines coupled direct to alternators, there will, at least, be variety in the neighbourhood; and if the results of all three are published, the somewhat archaic preference of Islington will not be without its value to

Willans & Robinson, Limited,
C. S. Essex, *Secretary*,

February 20th, 1894.

*Not the only Madrid station, by the way. We know of one with direct-driving engines by the celebrated firm of Van den Kerchove, *who are now making the Willans engine under license.*

Electric Lighting of Ships.

With reference to the rules and regulations for the electric lighting of steamships, Mr R. Kennedy advises the adoption of single wiring, stating that it has advantages over double wiring, and that the compasses are not affected any more than by the double wire system.

From most careful experiments, carried out at the Elswick Works, this, however, does not appear to be the case. It is found, by calculation, that a compass would not be affected in an ordinary sized ship if her decks and hull were of iron some 3 feet thick, and all wires kept below. But this design of ship is impossible; so it is found that some of our ships, electrically lighted on the single wire system, show, in many cases, disturbance of the compass of from 3° to 7°, when groups of lights in various parts of the ship are thrown on and off, as is customary in ordinary sea-going passenger ships.

Experiments were made on board a cruiser to see the effect single wiring had upon compasses. The current used was obtained from a shore dynamo about 80 yards distant from the ship, so that the dynamo could in no way affect the readings obtained upon the compasses. Using two of Sir Wm. Thomson's compasses, with six needles, and a current of 100 ampères, a single wire 3 feet above the compasses, and in a horizontal direction, gave a deflection of 58°. Next, the wire was fixed 6 feet in front of the compasses, the wire passing down vertically, and gave a deflection of 10°. Then the wire was placed 14 feet away, over the side of the ship, the wire running fore and aft, and gave 8° deflection; and at 20 feet away it was 7½°. In these latter two cases the iron side of the ship, intervening between the compasses and the cable, was ¼-inch to ⅜-inch thick, thus showing that the iron plating had very little screening effect on the compasses. Next, by passing the same wire directly under the compass running fore and aft, the deck between being partly iron and partly wood, and at a distance of 12 feet, the deflection was 12°. At 20 feet away, under an armoured deck, varying from 1 inch to 2½ inches in thickness, and practically without any openings, gave a deflection of from 2 to 2½°. At a distance of 10 feet, the compass being in this experiment in a conning tower, the mean diameter of which was 7 feet, and whose sides were 4 inches thick, with two iron floors each ⅜ths-inch thick, and a roof ¾-inch thick, there was still a deflection of from 2 to 2½°. These last two experiments went to prove that the effect of the current upon the compasses decreased with the thickness of the intervening plate. But, small as these deflections were, 2° were equal to 35 miles per 1,000, or in a voyage, say, from Queenstown to New York, an error of 105 miles; and a deflection of 2½° would give an error in the reckoning of 44 miles per 1,000, or, on the same voyage, an error of 132 miles. In cases of this kind an error of 2° might be attended with very serious consequences. I would like also to point out that double wiring possesses three other advantages over single wiring: 1. All corrosion of contact avoided where connection is made to ship's plating. 2. Only half the chance of a breakdown in double wiring, seeing that two points in the circuit must be earthed before the installation will become useless. 3. Owing to one wire of the single wire system being earthed, it is impossible to make a connection or repair a wire while the circuit is connected with the dynamo in action, owing to shocks which render it painful to those carrying out the repair, or joining up by ordinary terminals, such as is generally used upon reflectors. Summing up these points, the conclusions arrived at are:—

(1.) The serious effect upon the compass, which it is impossible to screen efficiently.

(2.) In the single-wire system there is twice the chance of a breakdown.

(3.) More danger of breakdown and fire through bad contact with the ship, or exposed wire eaten away by the salt water, which frequently attacks any such fixtures, however well they may be protected.

L. Muitt.

Society of Arts.—Mr. W. H. Preece delivered a lecture on "Electrical Signalling without Wires," on Wednesday last. We shall probably refer to this at length in our next issue.

REVIEWS.

*Medical Electrotechnics and their Physical Foundations.** By Dr. G. L. Hoorweg, of Utrecht. With 77 figures in the text. Leipzig: Engelmann, 1893.

Recent revelations must not blind us to the fact that there exists a *real* electrotechnic therapy, recognised by *real* electricians and *real* physicians, and not requiring to ensconce itself behind the venal shield of the law. There is room and need for a scientific exposition of electro-diagnostic and electro-therapeutic procedures. Such an exposition Dr. J. L. Hoorweg has here ably and successfully presented.

In the four preliminary chapters of his treatise the author expounds the general properties and laws of magnetism, static electricity, galvanism, and the methods and standards of electrical measurements.

In the fifth chapter we come to consider the action of electricity upon the human body. The author tells us that it owes its electro-conductivity principally to its proportion of moisture. But the appended table of moistures and conductivities scarcely bears out this view. Thus the moisture of muscle being 100 the conductivity is also 100, but whilst the moisture of the brain is only 106, its conductivity is 380. The specific resistance of muscular fibre is valued at about 236 ohms, and that of the skin, even when moistened with a warm solution of salt, is about 1,000 times greater. Only very powerful currents, which irritate the nerves of the skin to an unbearable degree, penetrate even feebly into the body.

The action of a constant current upon the brain is complicated. The chief symptom is dizziness, sometimes accompanied by vomiting and stupefaction. Induction currents do not have this effect.

The action of the current upon the blood is chiefly electrolytic and cataphoric. A constant current has the same action upon the liquids of all the tissues, a convection in the direction of the current transversely through the tissues, and, at the same time, a chemical change determined by the migration and the deposition of the ions.

The principal electro-medical apparatus are the self-exciting influence machines of Voss and of Wimshurst, which are here described and figured along with their auxiliary appliances. The chief galvanic elements mentioned are those of Grenet, Leclanché, Daniell, Meidinger, Marie-Davy, Noë's thermo-electric battery, &c. But some of our readers will, perhaps, be horrified at finding that electric belts, rings, hair-brushes, and the like are ignored. The methods of electrising described are franklinisation, galvanisation (according to Onimus and Trepied), true galvanisation (as effected by means of a constant battery of several elements.) It is pronounced questionable whether the procedure of Onimus and Trepied can effect anything appreciable even on prolonged application. The trifling electro-tonic and electrolytic effect of such a current will soon be cancelled by the polarisation of the tissues. A further method is faradisation with its modifications, such as the electric bath.

It is remarked that electric treatment is more developed than electric diagnosis.

The Elements of Co-ordinate Geometry. Part I. By W. Briggs, B.A., and G. H. Bryan, M.A. Second edition. London: W. B. Clive, 13, Bookseller's Row, Strand, W.C.

We are not surprised that this book should have gone to a second edition; it is certainly a very meritorious work of its kind. The general arrangement is good and the illustrations clear. The free adoption of different sizes of type to indicate the relative importance of the matter is a good feature, and is a material help to the student.

Induction Coils and Coil Making. By F. C. Allsop. London: E. & F. N. Spon, 125, Strand.

Mr. Allsop has certainly the knack of turning out a very practical book when he deals with any subject by writing about it; the present issue is no exception to this rule, and it should prove of considerable value to those interested in the manufacture of induction coils. In the first

* *Die Medicinische Elektrotechnic*, und ihre Physikalischen Grundlagen, 1893.

portion of the book, the general construction of medical coils is dealt with, and many of the accessories used with them are described. The description of "spark" coils which follows is fairly full, and the various methods of winding are well explained.

It is a little surprising that even the cheapest forms of coils are not wound in two sections, the use of a central division for the purpose is a very simple matter, and it entirely avoids that most objectionable feature in a coil, viz., an "inside end," which often gets accidentally broken (an incident provocative of bad language) and renders it necessary to entirely unwind the coil in order to repair it. The arrangement of the contact breaker in the smaller class of coils is seldom satisfactory, and it is a matter for wonder that something of a more mechanical nature has not been designed; even for large coils, in spite of the improvements introduced by Ladd and Apps, there is still something to be desired. No book dealing with induction coils would be complete without a description of the Polytechnic and Spottiswoode coils made by Apps; accordingly full descriptions are given of these. In the chapter following, experiments which can be made with induction coils are given; as a matter of fact, although the manufacture of these coils has always been a favourite pastime, the actual experiments which can be made with them are really very few in number, though they are of a showy character. The remaining chapters give details of "Batteries for coil-working," "Faults in medical and spark coils," "Figures produced by electric discharges on photographic plates."

Sell's Directory of Registered Telegraphic Addresses. H. Sell, 167, Fleet Street, London, E.C.

This is the first time we have been afforded the pleasure of reviewing a *complete* directory of telegraphic addresses, for one absolutely complete has not previously been issued from the press. Mr. Sell has done his level best to make his former annual issues perfect, but he has been severely handicapped through not being allowed to use the official lists in the possession of the Postmaster-General, as it is evident that without these lists all telegraphic names could not be included. After a great deal of determined effort, however, the compiler has succeeded in securing the long-sought special license from the Postmaster-General, which license costs him a considerable sum annually. We need hardly comment upon the necessity that exists for such a publication, suffice to say that codification in telegraphic messages and their names and addresses is becoming so general of late years that no telegraphing business house should be without this directory. The book contains the names of over 40,000 of the principal firms in the world. The benefit of the license will be observed when it is noted that the present issue contains three times the number of names given in the 1893 edition. In March, June, and September of each year will be published separately, supplementary lists setting forth all corrections and additions that may have been received up to each date.

AN INTRODUCTION TO DYNAMO DESIGN.

By KENELM EDGCUMBE.

It would seem that there must be many who after reading those portions of the ordinary text book, which are devoted to the study of dynamo machines, still find themselves unable to grasp the real bearing which the various formulæ, &c., have on the design of an actual machine. There are, it is true, numerous excellent works on the subject, but many have neither time nor inclination to enter into the innumerable details there discussed. It is hoped, therefore, that the following brief outline of the subject may prove useful, as affording at the same time an introduction to the use of the various tables, which have been compiled from time to time, for the assistance of dynamo designers.

The calculations do not pretend to accuracy, nor are the tables intended to be more than specimens of those which might be employed in actual practice.

Let us suppose then, that a series wound machine be required, yielding 2 ampères at 30 to 35 volts. For simplicity, we will consider one of the two-pole horse-shoe type, with drum wound armature.

Then, taking No. of revolutions per min. ... n = 2,000
No. of turns on armature ... N = 400
∴ No. of conductors round periphery ... N' = 800
and allowing for loss in armature and in magnet coils ... ... volts E = 40

Hence total number of lines of force urged through armature must be :—

$$\phi = \frac{60}{n} \cdot \frac{E \times 10^8}{N'} = \frac{60 \times 40 \times 10^8}{2{,}000 \times 800} = 150{,}000.$$

Assuming a density in armature,

$$B_a = 8{,}000 \text{ per sq. cm.}$$

Then the cross-section of armature

$$S_a = \frac{\phi}{B_a} = \frac{150{,}000}{8{,}000} = 18 \text{ sq. cm.},$$

which, allowing for iron lost through lamination of core, we will call 24 sq. cm. And, since the lines of force have a double path open to them through the armature, this may be attained by making the sectional area = 2 (6 × 2) sq. cm., *i.e.*, length 6 cm. and radial depth 2 cm.

Suppose the internal diameter be 4 cm., then external diameter = 8 cm.,

$$\therefore \text{ circumference} = \pi \times 8 = 25 \text{ cm.}$$

On this have to be wound 400 turns or 800 single wires, since each turn passes along one side and back the other.

Employing wire 0·8 mm. diameter, or, say 0·9 mm., with insulation, we can get on three layers with 270 per layer, or over 800 in three layers.

The length per turn would be some 30 cm., allowing for cross connections,

$$\therefore \text{ the 400 turns} = 120 \text{ metres.}$$

The resistance of 0·8 mm. wire = 0·035 Ω per metre (see table), and ∴ resistance of armature $= \frac{0{\cdot}035 \times 120}{4} = 1{\cdot}05\ \Omega$, since current flows through its two halves in parallel.

Next as to the magnets. Let us, for example, assume cores and pole pieces of wrought-iron and bedplate of cast-iron. Then we may take B_m of cores = 10,000 which, allowing for a loss of 20 per cent. through magnetic leakage, entails a sectional area

$$S_m = \frac{1{\cdot}20 \times 150{,}000}{10{,}000} = 18 \text{ sq. cm.}$$

∴ diameter of cores aprox. = 4·7 cm. Assuming them to be round.

The length we may make 7·5 cm.

For the cast-iron bedplate let B_c = 4,500.

$$\therefore S_c = \frac{150{,}000 \times 1{\cdot}20}{4{,}500} = 40 \text{ sq. cm.}$$

Which we may distribute as may be most convenient. The length will be some 10 cm.

Now, B of air gap, or rather H :

$$H = \frac{\phi}{S_{a \cdot g}},$$

and $S_{a \cdot g}$ = surface of armature embraced by pole-pieces and = aprox. 10 × depth = 10 × 7 cm.

$$\therefore H = \frac{150{,}000}{10 \times 7} = 2{,}200$$

and its length = 2·7 mm. (wire) + 2·5 mm. (clearance) = 5·5 mm. at each side of armature.

Now, we have all the materials for working out the ampère turns in magnet coils. They are :—

	B.	Length of path.	Amp. turns (see table.)
In armature ...	8,000	8 cm.	8 × 3·5 = 28
„ cores ...	10,000	7·5 × 2 = 15 cm.	15 × 4·5 = 67·5
„ pole-pieces	10,000	5·0 × 2 = 10 cm.	10 × 4·5 = 45
„ bedplate ...	4,500	10 cm.	10 × 6 = 60
„ air gap ...	2,200	0·55 × 2 = 1·1 cm.	1·1 × 1,800 = 1,980
		Total	2,178·5

To which should be added some 200 turns to compensate for the reaction of armature.

∴ Total ampère turns = 2,400, and since ampères = 2,

∴ Number of turns = 1,200, or 600 per limb.

Now thickness of coil may be taken at 2·2 cm. and length = 7·5 cm. per coil,

$$\therefore d^2 = \frac{22 \times 75}{600} = \frac{165}{60}$$

∴ d = 1·7 mm., with insulation, and diameter of wire alone = 1·4 mm., about.

Mean length per turn = π (4·7 + 2·2) = 21 cm.

∴ 1,200 turns = 252 metres, and resistance of 1·4 mm. wire = 0·011 Ω per metre (see table),

∴ Resistance of magnet coils = 2·75 Ω.

Thus the total drop in volts = C ($R_a + R_m$) = 2 × 3·8 = 7·6 v.

Where R_a = resistance of armature,

and R_m = resistance of magnets.

Therefore, true difference of potential at machine terminals = 40 − 7·6 = 32·4 v., and, therefore, electrical efficiency $v = \frac{32}{40}$ = 80 per cent.

We have now to consider loss due to hysteresis in armature core.

Employing the formula of Steinmetz:

Loss in ergs = $\eta \cdot B^{1·6}$ per ~ and per cubic cm. of iron.

Where η = coefficient of hysteresis and varies from 0·002 to 0·09 according to material. For soft iron η = 0·004 approximately.

$$\therefore \text{Loss} = \frac{\eta \times B^{1·6} \times n \times \text{vol.}}{10^7 \times 60} \text{ watts.}$$

and, taking values of $B^{1·6}$ from table, we have:—

$$\text{Loss} = \frac{4 \times 0·176 \times 2{,}000 \times 188}{1{,}000 \times 60} = 4·4 \text{ watts.}$$

The total loss of energy may be calculated as follows:—

From armature resistance ...	$C^2 R = 4 \times 1·05 =$	4·2 watts.
„ magnet coils „ ...	$C^2 R = 4 \times 2·75 =$	11·0 „
„ hysteresis in armature	=	4·4 „
Total		19·6 watts.

or, say in all, 20 watts are lost.

We have throughout ignored loss due to eddy currents, but if core be well laminated this should be small.

Steinmetz gives the following formula:—

Loss in ergs = ϵ N B^2.

Where ϵ = coefficient of eddy currents and varies from 0 upwards, according to lamination.

„ N = frequency of magnetic reversal.

We have, for the sake of simplicity, assumed a series-wound dynamo. For a shunt machine the calculations would be the same, only, since the current through the armature must of necessity be greater, its resistance should be kept as low as possible. The resistance of the magnet coils, on the contrary, is, of course, greatly raised.

In a series machine the total E.M.F. generated

$$E = \Delta + (R_a + R_m) C,$$

and, in a shunt,

$$E = \Delta + R_a (T + c).$$

Where Δ = terminal voltage C = main current.

R_a = resistance of armature c = shunt „

R_m = resistance of magnet (1·5 to 5 per cent. of T).

Should we adopt the ring armature, N = N′.

With magnets of either the Manchester or Crompton type, in which lines have a double path open to them, the cross section of each core may be halved, or nearly so, for the same values of B.

It will be seen that the ampère turns depend very largely on the length of air gap. This is especially the case with small machines. It should, therefore, be reduced as much as possible.

As a guide to the diameter of wire to be employed, we may allow a density of current in armature, according to ventilation, of from 2 to 6 ampères per sq. mm., and in magnet coils of from 1·5 to 3·5 ampères.

As to the commutator, the number of segments should, of course, be made as great as convenient, in order to prevent variation in E.M.F. (See Table.)

After what has been said, little difficulty should be experienced in dealing with a small motor of given output and voltage. We first reduce mechanical power to watts, and adding about 40 per cent. (for mechanical and electrical losses), divide by volts, and so get ampères.

In the case of a motor it is clear that

$$E = \Delta - (R_a + R_m) C.$$

Hence, by introducing effective voltage, E, into our first equation, we get ϕ, and then proceed exactly as before.

*Table of percentage fluctuation of E.M.F. with various numbers of commutator segments.**

Variation per cent. ...	50	14	2·4	1·1	0·61	0·29
No. of segments ...	2	4	10	15	20	30

Table of resistance per metre of copper wire.†

Diam. mm.	R in Ω.	Approx. B.W.G.	Diam. mm.	R in Ω.	Approx. B.W.G.
0·3	0·248	32	1·1	0·0184	18
0·4	0·139	28	1·2	0·0154	
0·5	0·088	26	1·3	0·0131	
0·6	0·062	25	1·4	0·0113	17
0·7	0·0454	23	1·5	0·0099	
0·8	0·0347	21	1·6	0·0087	
0·9	0·0274	20	1·7	0·0077	16
1·0	0·0222	19	1·8	0·0068	

Table of amp. turns per cm. of length.‡

Air, B	1,000	2,000	3,000		
Amp. turns	800	1,600	2,400	per cm.	
Soft iron, B	8,000	9,000	10,000	11,000	
Amp. turns...	3·23	3·65	4·26	5·02	per cm.
Cast-iron, B	4,000	5,000	6,000	7,000	
Amp. turns...	4	8	17·2	33·6	per cm.

Tables of values of $B^{1·6} \times 10^{-7}$.

B	$B^{1·6} \times 10^{-7}$	B.	$B^{1·6} \times 10^{-7}$	B.	$B^{1·6} \times 10^{-7}$
3,000	0·0365	7,000	0·1420	11,000	0·2925
4,000	0·0580	8,000	0·1758	12,000	0·3363
5,000	0·0828	9,000	0·2122	13,000	0·3821
6,000	0·1111	10,000	0·2511	14,000	0·4303

BOOKS RECEIVED.

Magnetic Quality of Iron. By J. A. Ewing, M.A., F.R.S., and Miss Helen G. Klaassen. (*Proceedings of the Royal Society.*) Price, 6s. 6d. Published by Kegan Paul, Trench, Trübner & Co., Charing Cross Road, W.C.

Spon's Architect's and Builder's Price Book for 1894. By W. Young. Published by E. & F. N. Spon, 125, Strand.

BUSINESS NOTICES, &c.

READY.—The Universal Electrical Directory (J. A. Berly's) for 1894. Orders for copies should be at once placed with Messrs. H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. The price of the book is 4s., post free.

Electricity at the Blackpool Tower.—The Manchester department of Messrs. B. Verity & Sons are now engaged on a large electrical installation at the new Blackpool tower. The lighting arrangements will consist of about 3,000 incandescent lamps and 80 arc lamps, and electric fans, pumps, cooking apparatus, search lights, &c., will be installed. The wiring will be executed upon the three-wire system. The generating plant will consist of two gas engines, each of 160 H.P., driving four dynamos of 75 H.P. each. The contract for electric lighting also embraces the buildings at the base, consisting of aquarium, assembly and concert halls, refreshment rooms, shops, &c. The engines will be driven by Dowson gas. A telephone system is being installed for communicating to the landings of the tower, and to other parts of the base of the building.

* Prof. S. P. Thompson.

† Conductivity taken at 57·1 at 0°C. R measured at 15°C.

‡ *Kalender für Elektrotechniker*, 1893.

Bristol.—Electrical Time Check.—This instrument, which is being placed upon the market by Messrs. King, Mendham and Co., of Bristol, is designed for use in factories and workshops, and is actuated and controlled by electricity. The men are provided with checks of a certain size, and these at the appointed hours are dropped by them through slots in the case into the proper receptacle, they are then removed, the numbers registered, and the checks hung upon a board ready for the men to take upon leaving, or placed in specially designed racks where they can remain to be taken out and dropped into the slot at the next period of checking. The slot in the case is opened at appointed times by means of electricity, the time of opening being governed by a clock, specially fitted with contacts, by which the slot is kept open for a longer or shorter period, for whichever the contact is adjusted. Directly the circuit is broken the slot

is closed. If the workman is in time, his check falls into the proper receptacle in the base of the apparatus, or through a special opening into the office behind; but should the time have expired during which the slot remains open, the check falls into a tray provided in front of the case, and is so returned to the man, who thus knows he is late. As the time approaches at which by rule he is admitted to work, the next slot opens and his check is received. The time check is fitted up in a polished wood case, and as many slots provided as are found necessary. Generally speaking, each time check is fitted with two slots—"Early" and "Late." A portable apparatus is supplied complete, with clock and battery, and this can be used on isolated work or where a gang of men are working under a foreman.

The City Lighting.—The City of London Electric Lighting Company have issued a special notice to all the consumers on their circuits. The circular is intended to meet a condition of things which affects all supply companies, viz., electric leakage on consumers' premises. It is estimated that nine-tenths of the leakage on the City system is due to defective insulation inside the houses, and nearly all the bad faults occur there. The company's engineer has recently been in communication with Mr. Preece on the subject. Mr. Preece suggested that a department of the company should be organised to test installations, and the appreciation with which his suggestion has been received is best shown by the circular. This is a matter which is undoubtedly assuming greater importance as lamps are added and installations grow older. The following is a copy of the circular referred to:—"The attention of the company is frequently drawn to defective insulation of electric conductors and fittings on consumers' premises. This may arise in a great variety of ways, but chiefly through employing inferior material and workmanship in wiring the buildings or allowing good installations to get into disrepair. When considerable leakage occurs the meters may register the lost current as if used by the consumer. Damage to buildings and fittings may also be occasioned. Unless careful tests are made by skilled men, leaks and incipient faults may long remain undetected, growing worse as time goes on. At present there is no public or other body charged with the duty of making tests on private premises, although an opening appears to exist for a testing authority of the kind. With the object of filling this want and placing within the consumers' reach a ready means of lessening any loss or risk, the City of London Electric Lighting Company, Limited, hereby gives notice that it is prepared to enter into agreements with consumers to examine their fittings, &c., at stated intervals on payment of an annual fee of 10s. The men who make the test will hand the consumer a signed report specifying the insulation resistance, with a note on the general condition of the wires and fittings at time of inspection."

Ipswich and Electric Lighting.—A report has just been presented to the Town Council on this subject. The chief points in the report are that the old Falcon Brewery might be the central station, that the area of the district lighted should include the principal streets in the centre of the town, that the cost of the plant would be £9,036, and of annual maintenance (including sinking fund for repayment of loan), £2,116 16s. Eighty townspeople in the roads mentioned would avail themselves of the electric light, if the rate at which it could be supplied did not much exceed the price of gas. It was estimated that the total revenue would be £2,350, or £234 more than the expenditure, so that the enterprise is expected to be self-supporting from the commencement.

Electrical Chemical Company, Limited.—This company's prospectus invites subscriptions for 26,000 10 per cent. preference shares of £5 each. We observe that these shares in addition to being entitled to a preferential dividend over the ordinary shares up to 10 per cent., have equal voting powers and a rateable participation in the further profits after the ordinary shares have received 10 per cent. The object of the company is to manufacture caustic soda and bleaching powder by electrolysis on a process that has been practically worked in Kent with excellent results for the past two years. Among the directors we observe the names of Mr. Evans, the chairman of the Paper Makers' Association; Mr. Martin Pirie, of the well-known firm of Alexander Pirie & Sons, Aberdeenshire; and Mr. John Hy. Walters, one of the proprietors of the *Times*. The success of the process is vouched for by the distinguished scientist Professor John Hopkinson, F.R.S., and by Mr. James Swinburne, M.I.E.E., the latter of whom in a letter dated December 20th, 1893, attached to his report accompanying the prospectus, states that "There is nothing to prevent its paying prodigious profits." Mr. John Leith of St. Helens, estimates these profits at £110,000 per annum. The patents, the validity of which are vouched for by Mr. Moulton, Q.C., F.R.S., are sold subject to the right of a number of paper makers and others to manufacture for themselves at 15s. per ton; should these rights be fully exercised there should be an income of £21,037 per annum from royalties, in addition to the above stated manufacturing profits of £110,000 per annum. We deal with this further in our City columns.

Electric Light at Edinburgh.—Last week Councillor Mackenzie delivered a lecture before the members of the South Edinburgh Merchants' Association at Edinburgh, on "The Present Position of Electric Lighting." Speaking with special reference to Edinburgh, he said that the central station at the West End (when completed) would be one of the best and most extensive out of London. With the plant put down they would be able to supply 40,000 8-C.P. lamps with 680,000 units per annum. Of course, it would take a year or two before they could expect to have this number fixed, and no doubt they would work at a loss for some time, but they had every reason to believe that within the next five years electric lighting in Edinburgh would be a flourishing and paying concern. When the demand came up to the capacity of the plant at present being laid down, they could double it for about £30,000. The Corporation had decided to have 160 arc lamps, which would likely cost the lighting department £3,200, being £20 per lamp per annum. Fully £1,200 would be saved in gas, so that the net additional cost might be stated roughly at £2,000 per annum, for which, however, twenty times the present light would be obtained.

Walkden (Salford) and Electric Lighting.—Some of the residents met together on 15th inst. to consider the question of forming a local electric lighting company. An electrical engineer's report was submitted. He calculated that about 1,400 8-C.P. lamps would be taken up, and that about 932 lights would be alight at the same time. The electrical machinery, in the event of using steam, would cost £336; the buildings, boilers, engines, &c., £1,004; and the laying of the cables, £300; making a total of £1,640. The maintenance of 932 8-C.P. lamps would cost about £337 a year, which sum deducted from £700 (the income from 1,400 lamps), would leave a margin of £323. In the event of using gas as the motive power, the cost of buildings, boilers, &c., would be approximately £1,300; electrical machinery, £364; and laying of cables, £300; a total of £2,000. The income from 1,400 lamps would be £700. Taking the cost of a unit, in the gas scheme it would be 1·18d., whilst with steam it would be 1·54d. Ultimately it was decided to adjourn the meeting in order that a practical lecture on electric lighting, cooking, &c., might be given in the district to awaken more interest in the scheme.

Liverpool Electric Lighting.—The Toxteth Park Local Board have issued the following scale of charges to consumers for testing:—

Tests to be Taken.

		Fees. s.	d.
Im,	Insulation of main ... ... Each test	5	0
Cu M,	Conductivity of main ... ... „	7	0
Is,	Insulation of service lines ... „	2	6
Cu S,	Conductivity of service lines ... „	4	0
Js,	Efficiency of joints ... ... „	3	6
M,	Tests of instruments of undertakers, per instrument	1	0
Tc,	Tests of electric lines of undertakers other than mains and service lines	2	6

Catalogues, Lists, &c.—We have, from Mr. Robert Jenkins, of 88, Bishopsgate Street, E.C., received illustrated lists of stampings for electrical purposes, including transformer stampings, forgings for dynamos, &c., as supplied by Messrs. Jos. Sankey and Sons, for whom he is agent. He also sends us a list of tests of steel castings made by the Springfield Steel Company, of Glasgow, for which company he is also London agent.

The Britannia Company have sent us a circular announcing that they have acquired the sole right to manufacture Root's patent oil engines. The circular gives full particulars and prices of the engines.

From Messrs. Dorman & Smith we have received a copy of their January, 1894, catalogue of electrical apparatus. Lampholders, switches, switchboards, cut-outs, pendants, electric light shades, and general electrical fittings are described in great variety. On the whole, the catalogue is a very good one well worthy of perusal.

Rothesay Harbour and Electric Lighting.—A Committee of the Harbour Trust has been appointed to report as to the introduction of electric lighting at the Harbour.

Drake & Gorham.—This firm have been entrusted with the electric lighting of the new offices of the *Morning* newspaper in St. Bride Street. The plant will consist of a Crossley Otto high-speed gas engine of 14 brake H.P., fitted with patent tube ignition and all the latest improvements. The machine will be an E.C.C. dynamo wound for 90 ampéres by 105 volts for running direct. Spring contact main switches, the patents for which are held by the firm, will be adopted. The lights at present to be arranged for are 140, but they will probably be increased later on to 200. Several of the arrangements designed by Messrs. Drake & Gorham for this installation will be interesting, and for the outside arc lamp a specially designed bracket of wrought-iron is being made with the device of the *Morning*. A complete system of bells is also being fitted.

Church Lighting.—On Thursday evening last week, St. Nicholas Church, Bristol, clock was for the first time illuminated by the electric light. Three 50-C.P. incandescent lamps are fixed behind, within 18 inches of the 5 feet opal dial, and provided with reflectors, so that the whole of the light is thrown on to the dial. The work forms part of the contract for introducing the electric light into St. Nicholas Church, which was entrusted to Messrs. King, Mendham & Co.

Business Announcement.—Messrs. W. Peto and F. W. A. Radford have purchased from Mr. Charles H. Cathcart his entire share and rights in the firm of Cathcart, Peto & Radford, and intend to carry on the firm as before, under the title of Peto & Radford. All liabilities, contracts, &c., of the old firm will be taken over by the new firm, and all monies owing to the firm will be collected by Messrs. Peto & Radford. The nature and style of the business will not be altered in any way.

The "Perfect" Lamp Pendant.—Messrs. Faraday and Son have issued a circular relating to Sir David Salomons's adjustable or "Perfect" pendant supplied by them. Reports having been spread that the patent term of this fitting had expired, they wish to make known that the renewal conditions have been periodically complied with. They hold exclusive rights from the patentee to manufacture, and many years must elapse before the patent becomes void.

Mill Lighting.—Mr. W. Boydell, of Brown Street Iron Works, Leigh, has laid down an electric light installation for Mr. H. Pennington, at the Butts Corn Mill, Bedford, near Bolton. In addition to the lighting of the mill premises throughout, Mr. Pennington's residence, and a portion of the "Wheat Sheaf" Inn will also be similarly illuminated.

Electric Light at Warrington.—Mr. J. Moore, the Bolton representative of Messrs. C. A. Parsons & Co., Newcastle, has completed an electric light installation in the premises of the Mersey Rubber Company, Warrington. It consists of 10 inverted arc lamps and 110 16-C.P. incandescent lamps. The current is supplied by a 12½ unit dynamo, which is driven by a vertical steam engine.

Ashford Lighting.—The Local Board having received a notification from the Gas Company that they cannot entertain a proposal for the purchase of their undertaking, a committee has been formed for the purpose of considering this reply, and considering the advisability or otherwise of taking the necessary steps to obtain an order for lighting the town by electricity.

Colchester and Electric Lighting.—The Lighting Committee have conferred with Mr. W. H. Massey regarding electric lighting. He recommends the Council to undertake the supply themselves. Several sites for a station have been inspected by the committee. Mr. Massey will report fully shortly.

Personal.—The National Electric Company have opened offices and showrooms for the supply of fittings and lamps at No. 2, Holborn Place, High Holborn, W.C., and have secured Mr. Arthur C. Cockburn, M.I.E.E., as their consulting engineer.

Electric Light at Derby.—The Midland Railway Company have lately opened at Derby a literary institution, at a cost of over £12,000, for the benefit of the *employés*. It is lighted throughout by electricity.

Electric Organ.—Arrangements to place an electric organ in the Gilfillan Memorial, Dundee, are now being made. It will be built on the principle of the Hope-Jones Electric Organ Company, Limited, Birkenhead.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—February 26th. The Harbour Commissioners are prepared to receive tenders for the supply of a Cornish boiler for the electric light station, Abercorn Basin. Copies of specification, forms of tender, and any further information required may be obtained from the Harbour Engineer, Mr. G. F. L. Giles.

Bury.—March 10th. Tenders for the supply of electric light fittings, including switchboards, lamps, wiring, &c., for lighting the technical school now in course of construction. Further particulars will be found among our advertisements.

Morley (Yorks.).—February 26th. For the electric light wiring of the town hall in course of erection at Morley. Specifications, plans, and particulars may be obtained from Messrs. Holtom and Fox, architects, Dewsbury, on deposit of £1, which will be returned on receipt of a *bonâ fide* tender.

Swansea.—February 26th. For providing and fixing, in lieu of existing wires, insulated cables for electric lighting purposes, on portions of their property, for the Swansea Harbour Trustees. Particulars, information, and forms of tender may be obtained on application to the Trustees' engineer, Mr. A. J. Schenk.

CLOSED.

Burnley.—The tender of Mr. Fletcher has been accepted for lighting certain rooms at the workhouse for £45.

Hanley.—The tender of Messrs. Spagnoletti & Crookes for the electric light wiring and fittings to the Corporation buildings, amounting to £3,034 14s. 1d., has been accepted by the Town Council, subject to confirmation by the Local Government Board as regards borrowing powers. By reducing some small amounts from the allowances for contingencies the contracts stand as follows:—1. Town Hall and Victoria Hall, £1,408. 2. Free Library and Boys' Reading Room, £129. 3. Museum and Technical Schools, £155. 4. Public baths, £144. 5. Market Hall and Fish Market, £878. 6. Butchers' Market, £176. 7. Electricity works, £110. Total, £3,000.

LEGAL.

Elmore Guaranteed Dividends.

In the City of London Court, on Monday, before Mr. Commissioner Kerr, the case of McGeagh *v.* Elmore's Foreign and Colonial Patent Copper-Depositing Company, Limited, came on for hearing.

Mr. H. C. Richards appeared for the plaintiff; the defendant company was unrepresented by counsel.

Mr. Richards said his client was induced to take shares in Elmore's French Patent Copper-Depositing Company by seeing a statement in the prospectus that a dividend of 10 per cent. would be guaranteed for the first year by Elmore's Foreign and Colonial Patent Copper-Depositing Company, and that there would also be a participation in further profits. The amount guaranteed had not been paid. The secretary to the French Company (Mr. J. Shurmer) was also secretary to the guaranteeing company, and the defence set up was that the prospectus making the statement was issued without the authority of the guaranteeing company.

Mr. Shurmer was then put into the box.

Mr. Richards: You were secretary to the guaranteeing company when the prospectus was issued?—Yes.

Was that prospectus true when you put your name to it as secretary?—I believe so.

Was that paragraph true that the 10 per cent. had been guaranteed by the Elmore's Foreign and Colonial Company?—Quite true.

You have paid the guaranteed dividend to a good many of the shareholders?—The French company has.

Where has it got the money from?—From the guaranteeing company.

Why have you declined to pay Mr. Foster McGeagh?—His shares were of an issue upon which the dividend had not matured at the time we paid those dividends that did mature.

In reply to Mr. Commissioner Kerr, Witness said the prospectus was not issued actually by the Foreign Company; they were not responsible for the actual working of it. The Elmores had guaranteed the dividend under certain conditions. Plaintiff's claim, he thought, was amply satisfied by the scheme of resuscitation.

Mr. Richards said the case was a test case, and other shareholders were awaiting the result of it before themselves taking action.

Mr. Commissioner Kerr (to witness): You must bring the money into Court.

Mr. Shurmer: Every other contributory has come into the scheme; they have not been paid their dividends.

The case was adjourned till Monday next.

NOTES.

Islington Vestry and their Clerk.—The Vestry have awarded £50 to their chief clerk (Mr. Munsey), in recognition of the extra and special services rendered by him to the Vestry and the Committee during the past two years in connection with the electric light question.

The Electric Lighting in the West End.—A *Daily Telegraph* correspondent complains of the gloom which, after the Empire and the Alhambra have turned out their electric lights, prevails in Leicester Square, Green Street, and thence past St. Martin's Vestry Hall and St. Martin's Church, across Trafalgar Square, to Charing Cross. A few nights ago, on his homeward way from a theatre by this route, he was nearly run over three times, and considered himself lucky when he found himself seated upon a 'bus with his limbs whole.

Radcliffe and Electric Lighting.—The Local Board have decided to confer with Messrs. Bennett and Preece regarding the proposed electric lighting of the district.

Derry Electric Lighting.—An additional £5,000 is to be borrowed by the Corporation for electric lighting, the amount originally estimated having been found to be insufficient to complete operations.

The New Pacific Cable.—The Canadian Government declare that they will support the Pacific cable scheme under certain conditions. A conference is to be held at Ottawa in June between the Canadian and Australian Governments, and the subject then comes up for full consideration. New Zealand colony will be represented at the Conference, as will probably also Hawaii.

English v. American Undertakers.—The New York *Electrical World*, in a recent issue, says: "In England all electric lighting plants and all methods of traction are in charge of 'undertakers'; in this country the only plants with which undertakers are concerned are those which are planted in cemeteries on the graves of deceased relatives, and the only case of traction in which undertakers are interested is the old style horse traction applied to hearses and funeral carriages."

The Northern Society of Electrical Engineers.—The following candidates were recommended by the council to be balloted for as members last Friday week, 9th inst.:—Bailey, Francis G., M.A.; Banks, William; Bellamy, Alfred; Chambers, John C.; Chapman, F. Morris; Coates, H. J.; Connolly, James; Connolly, John T.; Douglas, R. C.; Elliott, Chris.; Garbutt, A. E.; Hammond, Robert; Heywood, H. W.; Hirst, H.; Lindley, Herbert; Magnall, Alfred; Matthews, Robert; Nisbett, E. H.; Paris, E. Alexander; Parkinson, John B.; Prestwich, Ernest; Ramage, Percy A.; Simpson, Jos. F.; Taylor, Robert; Taylor, A. Lester; Wood, Arthur P.

Telegraphic Communication with India.—The recent paper on "Telegraphic Communication between England and India," read by Mr. E. O. Walker, before the Indian Section of the Society of Arts, was in many respects a very suggestive one. After dealing with the historical aspects of the subject, the question of revenue was very fully entered into, the general argument being that the present tariff was far too high, and that if the lines were duplexed throughout, a reduced tariff would result in such an increase of traffic as would more than compensate for the reduced charges. Mr. Walker states that the total amount paid for telegrams between India and the United Kingdom in 1891-92, viz., £270,000, was only about ¼ per cent. of the value of the total trade, and this restriction of traffic is attributed to the high rate which prevails. Small traders cannot afford to use the wires, and foreign telegrams are only sent by a few wealthy firms; private persons rarely communicate between England and India, by telegraph. Native firms are learning to deal direct with European manufacturers, and were telegraphic communication cheap, then a great stimulus would doubtless be given to trade. The question of course arises, to what extent could reduction be made, such as would bring the telegraph within reach of those who are now precluded from using it, and at the same time would not render working at a fair profit an impossibility. It may be questioned whether the proposed reduction to 2s. 6d. per word would really cause the volume of message work to very largely increase, in fact, there is very little data upon which to found a supposition that such would be the case, and Mr. Walker seems to argue simply from what his personal opinion on the subject is. The advent of the 6d. telegram in England has certainly not resulted in such an enormous increase in traffic as many prophesied, and we think the introduction of the 6d. rate for 12 words was much more likely to favour increase of messages than a reduction from 4s. to 2s. 6d. for one word would do. The Bombay Chamber of Commerce has, however, doubtless, solid reasons for stating that "the Chamber entertains not the slightest doubt that a fair reduction in rates would lead to an enormous development of traffic," though, possibly, the wish is father to the thought.

The Electric Lighting of Nice.—The electric lighting of Nice will shortly be inaugurated. The installation has been carried out by the Société Alsacienne des Constructions Mecaniques, of Belfort. The continuous current and the 3-wire system have been adopted. The boilers are of the Nœyer type, and are heated with coke; they can furnish about 5,000 kilogrammes of steam per hour. The steam engines, three in number, are compound and horizontal, and of the Armington and Sims type, making 210 revolutions per minute, each furnishing 175 H.P. The dynamos will be supplied by the Société Alsacienne. The installation will include a battery of Tudor accumulators of 1,200 ampère-hours.

Morocco Cable.—The ss. *Dacia*, belonging to the Silvertown Telegraph Company, left the Thames on Wednesday, carrying a cable to be laid between the Spanish possessions of Ceuta and Velez de la Gomera, both on the north coast of Morocco. The laying of this short cable will duplicate the communication between Spain and Melilla, as well as with other Spanish military posts on the Morocco coast. At a critical period during the recent trouble at Melilla, it was found that the cable recently laid by Messrs. Pirelli (an Italian firm) between Almeria (in Spain) and Melilla was faulty, and that a repair was necessary. This was effected by the ss. *Mirror*, of the Eastern Telegraph Company. To avoid a possible recurrence of such trouble, the Spanish Government have apparently hastened to complete the link which will practically duplicate the existing system.

The Indian Government Telegraph Department.—A subject which is at present much agitating the minds of the staff of the Indian Telegraph Department is the question whether the present Director-General, Mr. W. R. Brooke, shall retire immediately or continue in office for a further period of three years. It appears that much dissatisfaction exists owing to the slowness with which promotion takes place in the service. We, in England, find some little difficulty in appreciating the hardships which are said to exist in consequence of the stagnation of promotion. A comparison of the salaries of our own telegraph officials with those of the Indian Service show such a vast disproportion between the two, that even allowing for the extra cost of living in India, the low value of the rupee, &c., there certainly does not seem much for our Indian friends to grumble at. One is inclined, rather, to wax envious at the amount of the emoluments received by the higher grades, than to feel sympathy with those who are unable to quickly attain the same. However, the grievances appear to be genuine, and the reasons for urging the proposed retirement to be solid ones, and we therefore throw the balance of our opinion on the subject in favour of the course which shall ensure the desired advancement of many deserving officers.

The Police and Electrical Students.—A mild and inoffensive student of electrical engineering was passing along Regent Street the other day with a small accumulator under his arm, when two stalwart and intelligent members of the police force came up behind, and he was seized by the shoulders and dragged down a side street. The student was speechless with surprise; the omissions and errors of a life passed vividly through his mind, and a nemesis in blue cloth seemed to have overtaken him. He thought of the happy days that had gone for ever, and was about to exclaim that he would go quietly, when, in language which smacked of the plough, the two distorted limbs of the law asked him to show the contents of his mysterious package. With a fearlessness with which idiotcy was strongly blended, they tapped and shook the case, the trembling student unscrewed the top of the awful box, when the plates and the solution were disclosed to view. Policeman A, however, anxious for promotion, was not satisfied; he tilted the accumulator and some of the solution ran on to his hand, then he gave the box back to the student, muttered what appeared to be a silent prayer, and proceeded to execute a *pas de quatre* by himself. Matters were becoming serious, a large crowd was already beginning to admire Policeman A's agility, when Policeman B muttered an apology to the mild student, and led his too enterprising comrade away. Policeman A is not looking for bombs now.

Marriage.—On Tuesday last, Mr. H. D. Wilkinson, M.I.E.E., late of the Hanover Square School of Electrical Engineering, and well-known as a writer on submarine telegraphy, was married at Christ's Church, Crouch End, to Miss Morgan, of Cape Town.

The Société Internationale des Electriciens.—The ordinary monthly sitting of the Société Internationale des Electriciens took place on February 7th. M. Raymond presided. Dr. D'Arsonval spoke first of M. Bonetti's new electo-static machine, with ebonite trays without sectors, and afterwards of the manufacture of ozone in large quantities by electrolysis, and of liquid oxygen by means of alternating currents. M. Bandot then made a long speech on multiple telegraphy.

Electrical Entertainment.—On 15th inst. Mr. S. B. McClellan gave a lecture upon electricity at the Lewisham Conservative Club, illustrating the same with numerous experiments. An interesting item of the programme was an amusing reference to the Harness case. An electropathic belt having been obtained, its electrical properties (?) were explained. Several members afterwards subjected themselves to the influence of a powerful frictional machine. A system of telephones was temporarily fitted up with a resistance switched in, equal to 50 miles of overhead wire.

Fire at the General Post Office.—A fire broke out early on the morning of the 21st inst., in the central hall of the telegraph department of the General Post Office. The first news of the outbreak was given by clerks in the "tube" department, which is on the ground floor and immediately adjoins the hall of the principal entrance from Aldersgate Street. Several clerks are engaged in that department during the night receiving messages through the pneumatic tubes from various neighbouring offices. Flames were seen issuing from the flooring in one of the corners, and in a very short time the hall was filled with smoke. The Post Office fire corps, aided by a small army of other servants of the department, set to work with the service hoses, and by the time the first fire engine had arrived the fire had been practically subdued. The fire severely damaged several of the pneumatic tubes.

A New Form of Prony Brake.—An exceedingly ingenious modification of the Prony brake has been designed by Prof. R. C. Carpenter, and is described by him in *Cassier's Magazine*. The special modification consists in the use of a flat elliptical-shaped tube of copper nearly encircling the brake wheel, and an outer encircling band of steel to prevent the tube from expanding outwardly. Water is admitted under pressure to the tube, and causes it to press upon the wheel according to the water pressure and the absorption of work is easily controlled by regulating the supply and discharge of the water to and from the tube. The water acts also a cooler of the brake. An automatic device for regulating is proposed by Prof. Scribner, but has not been applied to the new brake, though it is suggested as very suitable for regulating the water valves, and so maintaining the weight arms in exact flotation.

Physical Society.—At the Annual General Meeting held on February 9th, Dr. Chichester Bell and Mr. Griffiths were appointed scrutators, and subsequently declared the following gentlemen duly elected to form the new Council :—President, Prof. A. W. Rücker, M.A., F.R.S.; Vice-Presidents, Walter Bail, M.A., Major-General E. R. Festing, R.E., F.R.S., Prof. J. Perry, D.Sc., F.R.S., Prof. S. P. Thompson, D.Sc., F.R.S.; Secretaries, H. M. Elder, M.A., 50, City Road, E.C., and T. H. Blakesley, M.A., M.Inst.C.E., 3, Eliot Hill, Lewisham, S.E.; Treasurer, Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey; Demonstrator, C. Vernon Boys, F.R.S., Physical Laboratory, South Kensington. Other members of Council :—Shelford Bidwell, M.A., LL.B., F.R.S.; W. E. Sumpner, D.Sc.; Prof. G. Fuller; J. Swinburne; G. Johnstone Stoney, M.A., F.R.S.; R. E. Baynes, M.A.; Prof. G. M. Minchin, M.A.; L. Fletcher, M.A., F.R.S.; Prof. O. Henrici, Ph.D., F.R.S.; Prof. S. Young, D.Sc., F.R.S.

Lecture.—Before the Junior Engineering Society a paper, on "The Construction and Working of Electro-Motors," was recently read by Mr. A. H. Dykes, A.I.E E.

Exhibition Lighting.—The approaching Exhibition at Milan is to be lighted electrically. The plant will consist of three 160 H.P. Tosi engines, connected to three dynamos, which will have a capacity of 400 arc and 700 incandescent lamps.

Book Announcement.—Messrs. Whittaker & Co. announce that the second volume of Sir David Salomons's book on Electric Light Installations (seventh edition) dealing with apparatus, engines, motors, governors, switches, meters, &c., will be shortly issued in their "specialists series"; the third and concluding volume is now in the press, and will deal with the application of electricity.

Electric Light Accident at San Francisco.—A dreadful affair occurred at San Francisco Mid-winter Exhibition last week. A lion tamer named Carl Thieman was going through his performance in the lions' cage, when the electric lights suddenly went out. Three of the lions immediately sprang upon Thieman, who was fearfully mangled. He was, however, rescued alive by the proprietor of the show, as soon as the lights were restored.

Electric Railway from Dublin to Howth.—A proposal is on foot to lay an electrical railway from Dublin to the top of the Hill of Howth. The line would proceed upon the present level road by the sea shore for a certain distance. It is proposed that when the line has been erected the Dublin Tramways Company should obtain powers to run electric cars on their line from Nelson's Pillar to Dollymount, on to which latter place the new line will join.

Electric Lighting of Great Missenden.—The village of Great Missenden is now lit by electricity. A 15 horse-power steam-engine drives a small dynamo which supplies 15 lights of 32 candle-power each. The system is low tension. The cost of installation has been small, while the charge for keeping the lamps going up to half-past ten on dark nights will be only £15 per annum. The company who has introduced it expect a considerable demand for the light for domestic purposes, and will also supply electricity for cooking.

Three Men in a Boat.—An alarming adventure recently befel three temporary cable hands belonging to the P.O. cable ship *Monarch*. The ship was at Guernsey on Tuesday, 6th inst., waiting for weather. The men in question, with others, got leave to go ashore, but would not return when the *Liberty* boat left the shore for the ship. They tried to reach the ship later in a shore boat, but broke a thole. The boat then became unmanageable and drifted out to sea. It was rough weather at the time, and grave fears were entertained of their safety. They were picked up much exhausted off Cape La Hague on the following Saturday by the ss. *Endeavour*, a ship bound for Havre from Baltimore. It is believed that they had been carousing.

Wiring of Ships.—At the meeting of the Institution of Civil Engineers, on 6th inst., a paper was read on "The Transport of Petroleum in Bulk," from the point of view of minimising the risks of fire and explosion, by Mr. Boverton Redwood, F.R.S.E., Assoc.Inst.C.E. Particulars were given of instances of the ignition of benzoline vapour by the discharge of electricity accidentally brought about in the industrial use of the liquid for "dry cleaning," &c. The precautions to be observed in the management of tank steamships were considered. He stated that the chief risk occurred during loading and discharging. At such times, therefore, smoking and the use or carrying of matches of any kind anywhere on board, as well as the employment of naked lights and fires (other than the main boiler fires, which should be banked) should be rigorously prohibited. The vessel should, except as regards the necessary marine lights, be lighted only by electric glow lamps, the ship being carefully wired, the positions of the switchboards being judiciously chosen, and any lamps used in spaces liable to become charged with vapour being of safe construction.

M. Cornu's Conference on Magnetic Synchronisation.—On January 24th M. Cornu held before the Société de Physique, the Société des Electriciens, and the Société des Ingénieurs Civils, a conference which greatly interested his audience. He discussed first certain definitions relating to pendulum movements, and then showed that a sinusoidal movement can only be synchronised when it is damped. He gave a series of explanations accompanied by very interesting experiments, but we have not space here to enter into the details of these explanations.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Lamina Accumulator (Elieson's British Patents) Syndicate, Limited.—This company's statutory return shows that out of a nominal capital of £12,000, in £1 shares, 4,007 shares have been taken up, with 5s. called on each of 3,757. A sum of £562 10s. has been received, £250 has been agreed to be considered as paid, and £376 15s. is still outstanding.

Saxby & Farmer, Limited.—The statutory return of this company shows that out of a nominal capital of £25,000, in £10 shares, 2,021 shares have been taken up, with the full sum called on 221 shares. An amount of £2,210 has been received, and £18,000 has been agreed to be considered as paid.

Newington, Priddle & Co.—This company, according to a document filed on January 17th, 1894, is being wound up under the provisions of the Companies' Acts, 1862 to 1890.

Swinburne & Co., Limited.—This company's statutory return shows that out of a nominal capital of £25,000, in 300 deferred and 4,700 ordinary shares of £5 each, 300 deferred and 1,686 ordinary, have been taken up. The full amount has been called on 100 deferred shares. £3 on each of 1,026 ordinary and 10s. on each of 660 ordinary shares. The total sum received is £3,908, and £2,650 has been agreed to be considered as paid.

Scottish Electric Battery Company, Limited.—The last return of this company shows that out of a nominal capital of £20,000 in 850 preference and 1,150 ordinary shares, all of £10 each, 1,050 shares have been taken up. The full amount has been called on each of the preference shares, and 200 ordinary shares have been allotted as fully paid. The total amount of calls received is £8,500, and that agreed to be considered as paid on 200 ordinary shares equals £2,000.

CITY NOTES.

The Electro-Chemical Company.

Too late to go through it thoroughly, we have received the revised prospectus of the Electro-Chemical Company. In our last number of 1893, we criticised a prospectus of the above company in an article entitled, "An Electrolytic Christmas Box." It appears that prospectus has been withdrawn, and the second shows that our criticisms and remarks have been taken into consideration, as the Electro-Chemical Company is no longer a mixture of chemical and electro-chemical methods for the production of soda either by the electrolytic or by the Leblanc process. The estimate is that £100,000 will provide all necessary working capital, buildings, land, plant, and machinery capable of turning out annually 6,400 tons (70 per cent.) caustic soda and 13,320 tons (36 per cent.) bleaching powder, and that the profit on the manufacture in combination of the above 19,720 tons of caustic soda and bleaching powder by this electrolytic process should be about £110,000 per annum. We cannot help hoping for the company and the shareholders that this is true! This is a real investment: £110,000 per annum for an outlay of £100,000.

The Electro-Chemical Company intends to erect works for manufacture, grant licences to paper and soap makers, oil refiners, bleachers, and other large users of these chemicals, who desire to manufacture caustic liquor or bleach for themselves; and it is anticipated that a considerable additional revenue will accrue from this source, as well as from the sale of, or license to use the foreign patents. All this is quite legitimate and natural, but we cannot accept the following statement, and we are quite prepared to discuss it: The apparatus for the manufacture of caustic liquor and bleach by the electrolytic process being very compact, simple and inoffensive in working, can easily be erected on the user's premises at a small outlay and worked *by spare engine power*, thus saving great expense in solidifying the soda and absorbing the chlorine in lime for transport, as well as all the charges for packing in drums or casks, and carriage.

How can people accustomed to the commercial applications of electrolysis venture to say that in paper mills, &c., chlorine and caustic soda will be manufactured by SPARE ENGINE POWER? We note that the company acquires from the vendor company all the British patents in respect of the different inventions used for the process, and *such patent rights* as have been obtained or applied for in respect of some of the inventions in France, Austria, Belgium, Italy, Norway, the United States and Canada, and all other rights of the vendor company in respect of the inventions. "Such patent rights" in respect of some of the inventions seems to show that some of the patents have been granted in Norway and the United States, and that some have not. Russia and Germany, at all events, do not appear to have granted any at all.

We are at a loss to understand why the opinion of the well-known Mr. Fletcher Moulton has not been published; can it be that the eminent and highly competent authority in matter of patents and patentability has not been altogether favourably disposed? For our part, we consider that the Richardson-Holland process is a great advance in the electrolytic industry; that it will certainly pay substantial dividends, but we entertain some strong doubts as to the validity of certain patents, and we confine ourselves to pointing out the similarity of the copper cathodes coated with oxide of copper of the Electro-Chemical Company with those described and patented before by Mr. Desmond FitzGerald.

The last paragraph of the prospectus says:—"Should all *these optional rights be fully exercised*, and the *maximum number of tons licensed be manufactured, the net additional income receivable* by this company from these royalties alone would be £21,037 per annum." We take the liberty of adding that if the company sell all the patents, and grant a license to every paper maker, oil refiner, bleacher, &c., on the Continent and in America, the profits will be still larger, and we sincerely wish the Electro-Chemical Company may secure the most brilliant success, to the credit of electrolysis and the profits of its supporters.

Scarborough Electric Supply Company.

As the public supply only commenced in September last, the report of the company is naturally a statement of liabilities and assets. It will be remembered that the company started with capital powers of £50,000, in 5,000 shares of £10 each. A call has been made of £8 on 2,420, which was the number subscribed for. £21,000 has been spent on lands, machinery, &c. The directors are sanguine of the prospects of the company, and there is abundant evidence of good business. On February 13th, 4,489 8-C.P. lamps had been connected, and 6,000 are expected to be connected by March, the present plant providing for 10,000 lamps. We shall watch the working of this station with the greatest interest.

Kensington and Knightsbridge Company.

In our analysis of the Kensington and Knightsbridge Company's accounts, we omitted to include in the cost per unit the sum of £2,762 for maintenance of buildings, mains, plant, &c. Adding this sum brings the total cost per unit to 5·17d. It will have been noticed that we gave the works' cost per unit in our table last week. This was an error, for we have found it so difficult to arrive at the exact works' cost, that we intend to omit it for the present. We have corrected these items in this week's table of comparison.

Notting Hill Electric Lighting Company, Limited.

In all respects the results for 1893 are a distinct improvement on those of previous years. The revenue account shows a profit of £1,481, compared with £112 for 1892. The company has wisely placed the costs incurred in the Hopkinson lawsuit to capital account, which is decidedly better than saddling the year's working with such an abnormal sum. There is a considerable increase in the number of units sold, the number being 107,580, against 75,667.

The number of houses supplied has increased from 124 to 173, and the number of lamps from 9,438 to 12,153.

The directors state that the cost of generation during the second half of the year is lower than that appearing in other companies' accounts published hitherto. Unfortunately one cannot see yet where

AN 1893 COMPARISON OF SOME SUPPLY COMPANIES.

	Capital.	Units sold during 1893.	Lamps connected.	Revenue from sale of current.	Average price obtained per unit.	Works cost per unit (exclusive of rent, rates and taxes).	Total cost of producing a unit.
Westminster Electric Supply Corporation	£400,000	1,704,605	131,565	£41,949	5·9d.	2·27d.	4·02d.
Chelsea Electricity Supply Company	£99,483	402,848	40,665	£13,078	7·7d.	2·78d.	5·03d.
City of London Electric Lighting Company, Limited	£799,610	1,741,099	65,341*	£37,156	7·56d.*	3·096d.	3·547d.*
Charing Cross and Strand Electricity Supply... ...	£211,200	...	34,570	£20,827	...	...	...
Newcastle and District Electric Lighting Company ...	£44,278	388,422	4,000 (10 C.P.)	£6,880	4·25d.	...	3·01d.
Kensington and Knightsbridge Electric Lighting Co...	£174,260	724,308	64,529	£20,746	6·8d.	...	5·17d.
Notting Hill Electric Lighting Company	£78,480	107,580	12,000	£3,507	7·81d.	3·84d.	7·4d.
Yorkshire House-to-House Electricity Company, Ltd.†	£45,270	130,068	...	£3,771	...	...	5·44d.
St. James's and Pall Mall Electric Light Supply ...	£211,029	...	...	£29,766	...	...	...

* Refer to private supply.

† Eight months' working.

these economies have been made, because in analysing the cost of working, those outside the company have to consider the output for the whole year. Our analysis shows that the total cost per unit is 7·4d., against 7·98d., though it is only fair to mention that the cost of management figures high, because the directors are taking £400 out of revenue. One would have liked to see the total cost unaffected by directors' fees, but it is a legitimate claim, and must therefore be set against the year's working.

The contrast, however, between working costs for 1893 and 1894 is most happy, and would seem to bear out the contention of the directors that great economies have been made.

We make the working cost as low as 3·84d., which compares excellently with what was accomplished last year, when the works' cost per unit was about 6d. One would have naturally expected the increased output to lower the cost of coal, but to bring it down from 1·37 to ·96d. is worthy of note, and we must congratulate the managing engineer, Mr. Shultz, upon bringing the station accounts into favourable comparison with those of other London companies. We have much pleasure in including the company in our 1893 comparison, where, in the matter of works cost, the company has no reason to feel disgraced. The result is all the more gratifying, because the company has had a hard struggle to get on to a dividend-paying basis.

	1891.	1892.	1893.
Total capital invested... ...	£70,020	£77,850	£78,480*
Number of units sold	29,985	75,667	107,580
Number of lamps connected ...	5,950	9,440	12,000
Revenue from sale of current...	£1,000	£2,519	£3,507
Net revenue	—	—	£1,481
Average price obtained per unit	8d.	7·98d.	7·81d.

* Total expenditure, £78,528.

Cost of Production.	£ s. d.	Per unit.
Coal	431 19 9	·96d.
Oil, waste, water, and engine room stores	122 13 6	·27d.
Proportion of salaries of engineers and wages at generating station	508 18 8	1·24d.
Repairs and Maintenance.		
Buildings, engines, boilers, dynamos, motors, accumulators, and other machinery	617 5 6	1·37d.
Rents, rates and taxes	260 5 11	·58d.
Management Expenses.		
Directors' remuneration, salaries of managing engineer, secretary, clerks, stationery and printing, general establishment charges, auditors, insurance, &c.	1,317 8 4	3d.
Depreciation account	none	
Redemption fund	none	
Total	£3,288 11 8	7.42d.
REVENUE.		Average price obtained per unit.
By sale of current	3,507 4 8	7·81d.
Meter rents	182 4 6	
Total	£3,689 9 2	7·81d.

Yorkshire House-to-House.

THE accounts of this company only cover a period of eight months, so it would be unfair to criticise too closely. The net profit amounts to £1,155, out of which the directors recommend that £1,000 be appropriated in reduction of the preliminary expenses account, carrying forward the balance of £155. The coal strike added somewhat to cost of production, but the works have been conducted most economically during the period under review.

To meet expected demands a further extension of plant has been decided on, and tenders have been accepted for 800 I.H.P., the capacity of the works will be thus increased from 700 to 1,500·01. Of the proposed reduction at Easter from 8d. to 7d. in the price per unit, we spoke a few weeks ago.

The number of units generated during the eight months was 130,068. The total cost, including interest on loan, comes to 5·44d.; excluding this, the total cost per unit is 4·98d., which is remarkably good showing. We have added interest on loan to the cost of working, because we consider it almost takes the place of rent; the loan, we take it, being raised on the land, which the company has bought outright.

	1893.
Total capital invested	£45,270 0 0
Number of units sold	—
Number of lamps connected	—
Revenue from sale of current	£3,771 7 4
Net revenue	£1,155 6 1
Average price obtained per unit	—

Cost of production.	£ s. d.	Per unit.
Coal	667 17 4	
Oil, waste, water and engine room stores	145 9 2	
Salaries and wages of engineers and workmen	890 17 10	
Repairs and maintenance	190 14 9	
Rates and taxes	114 3 2	
Management expenses, directors' remuneration, salaries of secretary and clerks, stationery and printing, law expenses, general establishment charges and insurance	697 2 2	
Depreciation account	none	
Redemption fund	none	
Interest on Loan..	240 0 0	
Total		5·44d.
REVENUE.		Average price obtained per unit.
By sale of current, rental of meters and other apparatus	£3,771 7 4	

City of London Electric Lighting Company, Limited.

SIR DAVID SALOMONS yesterday afternoon presided at the annual meeting of this company. In moving the adoption of the report, he said he thought any impartial person reading it would agree with the directors that it was a very fair statement; nothing was exaggerated, either for or against. The gas companies had grumbled that the past year was a bad one from the want of fog, and it had naturally affected the Electric Light Company in the same way. Notwithstanding this, they were rather glad they were free from fog, as they were busily

engaged erecting machinery, and very likely if fogs and dark days had been the rule, they would have been full of difficulty. They would, however, not be in that state again. During the greater part of the year the revenue had been made off the pioneer stations. The one at Wool Quay is still working, and that at Bankside will remain there for the present also. At the latter station the total lamp producing energy was equal to 34,000 8-C.P. lamps without reserve. In the beginning of 1893 there were 20,241 8-C.P. lamps connected to the system, with a current supplying capacity equal to, roughly, 32,000 lamps. At the middle of last year there were 45,919 lamps connected, and machinery to supply approximately 34,000 lamps. At the end of last year there were 65,341 lamps connected with machinery capable of supplying 64,000. Thus, it would be seen, the machinery had been gradually going up till they had almost reached the number of lamps connected with the system. At that moment there were, in round numbers, rather more than 76,000 lamps connected with the network, and machinery to supply 100,000 lamps. In a very short time the supplying power will be greatly increased, and the machines which are now in course of erection, not completed, will be ready to supply. There are still some 25,000 lamps applied for not yet connected with the mains, but they will be connected the moment that the transformer sub-stations are equipped. Taking a sanguine view of the matter, the whole of the sub-stations will be ready and alive by the end of April; generally estimates did not come out as one expected, but certainly, barring some unforeseen accidents, they will all be ready for use by the end of the half-year, and ready to supply current, so that the 25,000 referred to, and future applications, would be wiped off as lamps unconnected, and would be supplied. Previous experience had shown that when they canvassed for the supply the response had been very poor, but when the mains were laid down at people's doors, they immediately made application for the supply. That had been their experience. Judging from the number of lamps used in the present nine lighted areas, which appeared to be equal to 76,000 lamps, they might assume that in this proportion the remaining 13 areas would give a total of something like 180,000 for the whole of the City. That was a very low estimate of what they might expect at a very early period. They were taking measures to secure a night load which would greatly produce economy, for instead of having the machinery, &c., lying idle at night, they would be able to earn some income during that time. In about a week or 10 days they would be assisted in that direction. The board had decided to start, apart from the ordinary depreciation fund, one which would include the mains; that fund was invested in consols. The board had felt some anxiety about meeting the demand for current, which had increased in more rapid strides than they were able to supply it. That difficulty had now been overcome, as the first set of their new buildings were nearly ready, and they would now have no further difficulty with dust and such like inconvenience. Since the current was turned on day and night some two years ago, the total number of extinctions, taking all the small ones summed up together, had been considerably under one hour. The public lighting had also been very free from breakdowns. The most serious one was the bursting of a steam valve, which was rapidly remedied by the engineer at Bankside. The City authorities had only spent 1s. 2d. up to July last on account of breakdowns. The gas lamps were now to be removed from the streets, and this company should take it as a compliment to the safety of their supply. They apologised to intending consumers who had been waiting some time for the current, but the delay was really unavoidable. The general opinion among consumers was that the light gave satisfaction. The bills of some were higher, and others lower, than with gas lighting. The number of customers now numbered 1,420. A large number of lights are applied for every week. They had received an order to light right round Smithfield Market, and shortly they hoped to receive the order to light the lesser City streets. Experiments regarding the latter had been made, and they were in daily expectation of receiving the order. There is a very difficult working proceeding at the works at present, *i.e.*, laying very large cast-iron pipes in the bed of the Thames for the condensing plant. They had now reached the turning point in the company's career, and a good future was before them. During the recent tremendous frost they had no water at the works for the boilers. They overcame the difficulty by getting the Fire Brigade to lend them power, and they pumped sufficient water from the Thames to meet their requirements. Such a difficulty would not occur when they had their condensing plant. In a few days they intended issuing £100,000 5 per cent. debenture stock. This was no new intention; they fully reckoned upon it when the original prospectus came out. This stock would start at once earning dividends. They were considering whether to publish regular quarterly or otherwise, various returns of the company, similar to the railway companies. The loyalty and intelligence of the staff and officials could hardly be overrated. The number of shareholders was 1,700. The whole of the company's work had, so far, been carried out without any loss of life due to electricity. He then moved the adoption of the report and accounts.

Mr. J. B. BRAITHWAITE, Jun., seconded the motion, which, after some discussion, was carried *nem con.*

The retiring directors and auditors were re-elected.

Kensington and Knightsbridge Electric Lighting Company, Limited.

THE seventh ordinary general meeting of this company was held on Thursday last week, at 1, Great George Street, Westminster, Mr. Granville R. Ryder, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said: It is gratifying after working away at this company several years to be able to present to you what is in all respects a satisfactory report, and not only satisfactory so far as it shows that we are able to give you a further 1 per cent. dividend, but also in the prospect which it gives us of the future. With regard to the figures, I think the increases in them are encouraging. Of course, as a basis of comparison, it is necessary to keep back the new district and confine ourselves entirely to the old district, the new one only having come in for a broken period of the year. I find that we have increased the number of houses and shops connected with the system from 550 in 1892 to 650 in 1893. With regard to the 8 C.P. lamps we have increased the number from 47,441 to 59,267, an augmentation of 11,826. After deducting from the 724,308 units of electricity sold in 1893 the 28,600 required for the new district, we have a total of 695,708 units for the old district as against 535,343 for the year 1892. That is an increase of 160,365. The satisfactory thing about this increase of one-third in the electricity supplied, is that it was obtained at an increased cost of only about one-sixteenth. The gross earnings, less rebates, for 1892 were £16,628, whereas for 1893 they amounted to £20,746, an increase of £4,117 in the 12 months. Now, it is especially gratifying to find that the profit on that increase has been over 50 per cent. That is to say, the additional profit has sprung from £6,828 to £9,049, an increase of £2,221 on the enhanced gross earnings of £4,117. It might be alleged that we have reached the limits of expansion in our district. As a matter of fact, I consider we have done little more than touch the fringe of the business which we may look to obtain in future years. If you take Prince's Gate, Rutland Gate, Ennismore Gardens, Exhibition Road, and other roads of a like character in the neighbourhood, all inhabited by better class people, I think you will agree with me that they will all eventually have the electric light. Then there are large flats being built in different parts of the estate, and large houses are being converted into flats, which are good customers of ours. It is no doubt thought by many that the time would come when we must reduce our price. When that time arrives I cannot say that I shall fear the result very much, because with a reduction in price will come a great increase of business, and with it a cheaper output of electricity. Therefore I think there will be a considerable compensation for any loss in price by increased business and the reduction in the cost of supplying the electricity. With regard to the capital account, which we do our best to put down, I may say that in a company like ours it is impossible to altogether close it. During the past year it has increased by £19,860, being made up of £7,260 of the 5 per cent. second preference and £12,600 of the 4½ per cent. mortgage debentures. That increase of capital has been spent on the purchase of the freehold of one of our stations, the purchase of the new district from the Chelsea Company, on laying additional mains, &c. The next point to which I wish to refer is the writing down of the renewal account. What we feel is, that while we are increasing our profits we should try and write down to the largest extent we can, in fairness to the present shareholders. We have written off against preliminary expenses and the cost of the debenture issue about £379, thus reducing that amount to £500, and we have written off law suspense account £779, and in other ways we have made provision for depreciation and renewals, amounting in the aggregate to £2,456, which I think is a considerable sum for one year. It is impossible to say very much about the new district for the short time we have been working it. Its gross revenue for the half-year we have had it has been £953. I cannot say how much of that is net profit, but I shall look for from 9 to 10 per cent. in future upon the outlay.

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the motion.

The resolution was unanimously carried.

The CHAIRMAN moved the declaration of a final dividend, making 5 per cent. for the year on the ordinary shares. Mr. G. H. HOPKINSON seconded the motion, which was carried.

A sum of £500 was voted to the directors for their services during the past year.

The retiring directors, Mr. R. W. Wallace and Mr. A. S. Bolton, were re-elected, and Messrs. Lovelock, H. W. Whiffen, and Dickinson, the auditors, were also re-elected.

Chelsea Electricity Supply Company.

THE annual meeting was held at Chelsea on Tuesday, Mr. J. IRVING COURTNEY presiding, who said that during the year 1893 progress had been so satisfactory that there was a considerable increase in the profits, the dividend they recommend this year being double that paid last year, on a paid up capital which is over 10 per cent. larger than that of 1892. He wished it to be clearly understood that the dividend came out of the ordinary business of supplying current, and was quite independent of the exceptional item of the sale of the South Kensington district. They had complied with the views of the Board of Trade, and taken a large sum from preliminary expenses and placed it to a suspense account. This amount, under ordinary conditions, would legitimately have remained in capital account, and have been dealt with year by year; the directors have, however, decided to write £2,500 off this amount in the general balance sheet; they have also placed a further sum of £1,000 to renewals and depreciation fund account. Out of the balance the directors recommended a dividend of 5 per cent. on the share capital, which will absorb £2,485 18s. 4d., leaving £619 4s. 3d. to be carried forward. The expenditure for the year on capital account, as shown on page 2 of the accounts, is £18,118 17s. 6d. The actual amount is considerably larger than that, as they will notice that the credit of £5,453 10s. 4d. opposite the item of preliminary expenses has been deducted from that column. A large portion of this expenditure was due to an extensive increase in the mains, for besides the ordinary small extensions always necessary, they had covered a large area extending from the Chelsea Embankment on the south to the Fulham Road on the north, and they believed from the direction which rebuilding is taking, that this area will in the future develop in the same manner

and to a similar extent as the area previously occupied by our mains has developed. Alluding to the purchase of the works of the Cadogan Company, he said the station at Draycott Place was now quite full of plant, and the buildings in Manor Street, Cheyne Walk, purchased from the Cadogan Company, were being arranged so that boilers and machinery for 1,000 effective horse-power could be fixed there. The number of our customers in the new area in which the mains have been laid was rapidly increasing, and there was also a large increase in the area previously supplied, so much so that the Cheyne Walk Station was now about to be used to assist the Draycott Place Station as well as to supply the new area. The cost had been reduced within the last three years by the amount of 1¾d. per Board of Trade unit sold, and they would appreciate the effect of this reduction on the sale of 402,848 units last year. The number of units sold would have been still larger had it not been for the unusual absence of fog. The increase in capital expenditure had resulted in a much larger proportion of profits, a result to be expected, as not only were there certain fixed charges which barely increased at all while the revenue increases, but adequate capital enabled them to provide and arrange the plant so as to give the results. It would interest them to note that the capital expenditure and the payments from profits of debenture interest and dividends for the last three years have been as follows:—

	Capital expenditure.	Paid out of profits.
1891	£74,721 ...	£1,206
1892	81,364 ...	3,002
1893	99,633 ...	4,630

In conclusion he moved the adoption of the report.

Charing Cross and Strand Electricity Supply Company, Limited.

The annual ordinary general meeting of this company was held last Tuesday at St. Martin's Town Hall, Charing Cross, Mr. G. H. Brougham Glasier presiding.

The Chairman went over the several items mentioned in the report. Two actions which had been taken against them for injunctions and damages had been decided in their favour. They might congratulate themselves upon the results. They deeply regretted the death of their late chairman, Mr. Spencer Chadwick. The stations had been kept in a high state of efficiency. He moved that a dividend of 4½ per cent. per annum be declared for the year 1893, payable on February 27th.

Mr. J. P. Mendoza seconded.

Replying to questions, the Chairman said they would have had a 6½ per cent. dividend, instead of 4½ per cent., had it not been for a competitive supply company cutting their rates, which compelled this company also to reduce; £6,041 odd was down in the balance-sheet as owing to the company for current supplied. Since December 31st a very large portion of that sum had been received.

The report was unanimously adopted.

The retiring directors and auditors having been re-elected, the meeting closed with the usual vote of thanks.

Westminster Electric Supply Corporation.

The ordinary general meeting of shareholders of this corporation was held in the board-room, Eccleston Place, Westminster, on Wednesday, Lord Suffield in the chair.

The Chairman, in moving the adoption of the report, congratulated the shareholders on the steady increase that had been going on in the business of the corporation, and also in its income and dividends. He was glad to say that their revenue had largely increased, notwithstanding the adverse circumstances which had had to be encountered, and which included, first, the strong competition to which the corporation had been exposed; in the second place, the fact that the charge per unit had been reduced by 1d. for nine months of the year; and thirdly, the abnormal amount of light that had prevailed during the winter to the almost entire absence of fogs. The directors now recommended the payment on March 1st next of a dividend at the rate of 5 per cent. per annum for the half-year ended in December, carrying forward a balance of £1,191. The aim of the board had been to pay dividends out of actual profits, and to put the business of the corporation on a sound basis rather than pay large dividends at the commencement. They were, however, highly pleased to be able to declare to-day an increased dividend over the corresponding period of the previous year. During the past year, in conjunction with other low tension companies in London, the board had come to terms with the Westinghouse Electric Company for the use of the Hopkinson patents for the three-wire system of distribution, and had obtained a license for the remaining term of the patents and any extension thereof. The cost of the license had been £3,878, and as the issue of the patents had saved a much larger expenditure in copper for the mains, the amount had been charged to capital. There was no likelihood of their having to incur any further outlay for patents of any kind. No item chargeable to revenue had been carried to the capital account, the plant, machinery, &c., being fully maintained out of the revenue of the year. The Corporation had been but little affected by the coal strike, as they had provided a large supply beforehand, which had carried them over the bad period. Allusion had been made to what was called the satisfactory decrease that had taken place in the cost per unit generated, and he might add that a further saving had been effected during the year, so that the board had been able to make a reduction to 6d. per unit, and still show a larger profit on revenue. Owing to the increase in the number of lamps installed, the board had found it necessary last autumn to obtain further capital, provision for which had been made to the amount required. The installation of current to the mains for the supply of the Foreign Office had been satisfactorily accomplished. The Government authorities had decided on doing away with the plant previously supplied for lighting the Houses of Parliament, and would now take the whole supply for those buildings from the corporation mains. It was hoped before long other large Government departments would be added. At the present time the corporation was supplying 25 per cent. of the total number of houses in Mayfair with the electric light, and 15 per cent. of the houses in Belgravia, while a large proportion of the houses in Westminster, which he was unable to estimate, also had their supply from the corporation. There had been a large increase in the number of lamps on circuit, and at the date of the directors' report equivalent of 14,268 lamps of 8 candle-power were actually connected with the corporation's mains, while there were applications to the extent of 9,451 lamps more. At the present moment there were the equivalent of 135,255 lamps of 8 candle-power actually connected with the mains, while there were applications for 9,991 lamps more. It was a matter for congratulation that a large number of the consumers who had had experience of the light for some time had added considerably to their installations.

Mr. J. H. Powell seconded the motion for the adoption of the report, which was agreed to unanimously.

Oriental Telephone and Electric Company.

An extraordinary general meeting of the above company was held on Wednesday at Cannon Street Hotel, Mr. William Addison in the chair, to consider resolutions for winding up the company voluntarily with a view to its reconstruction, and authorising the sale of the undertaking to a new company with a nominal capital of £200,000 in shares of £1 each.

In proposing a resolution in accordance with the object of the meeting, the Chairman said that after the recent decision of the House of Lords, unfavourable to the contention of the holders of vendors' shares, the board was approached by three or four of the largest holders of these shares with a view to endeavour to arrive at a compromise fair and equitable to both classes of shareholders. After several protracted meetings a provisional agreement had been arrived at in the terms set out in the resolution. The ordinary shareholders would have to submit to a reduction of 1s. a share, but the vendor shareholders also reduced their 20s. shares by 4s. 6d. each.

The motion having been seconded, the working of the scheme was explained by Mr. Joseph Addison (the solicitor of the company), who also referred at some length to the late litigation in connection with the company.

A discussion followed, in the course of which speakers representing the ordinary shareholders dissented from the proposal before the meeting as unfair, while on behalf of the holders of vendors' shares it was contended that the latter under the scheme were giving up a great deal more than they ought to. An amendment was moved postponing the proposal until after the annual meeting had been held and a dividend for 1893 had been paid, and appointing a committee of three shareholders to confer with the directors as to any arrangement with the holders of the vendors' shares. On being put to the meeting the amendment was lost, and the original motion was afterwards submitted, 17 voting for it and seven against it. This result not giving the requisite three-fourths majority, a poll was demanded by the chairman, and at once taken, it being subsequently announced that, without the proxies or the votes of the board, there were 44,456 shares in favour of the resolution, compared with 1,162 against it.

Brush Electrical Engineering Company, Limited.—The directors of this company have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. (the maximum which, according to the articles of association, can be paid on an interim dividend) on the ordinary shares of the company, for the six months ended December 31st, 1893, payable March 1st, 1894.

The Unbreakable Pulley and Mill Gearing Company, Limited.—The directors have declared a dividend of 8 per cent. for the past year (as against 7½ per cent. for the previous year), placing £400 to the reserve fund, and carrying forward £784 17s. 7d. to next account.

The Dover Electric Supply Company.—This company held its first statutory meeting on 15th inst., when a very hopeful view was taken of the prospects of the electric light undertaking in Dover.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 18th, 1894, amounted to £938; week ending February 19th, 1893, £938; total receipts for half-year, 1894, £6,665; corresponding period, 1893, £5,800; decrease, £135.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,287.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 14th	Closing Quotation, February 21st.	Business done during week ended February 21st. Highest.	Lowest.
184,500£	African Direct Teleg, Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	43 — 45	42 — 44	...	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	80½— 81½	78½—79½	81½	79
2,932,680£	Do. do. Defd.	Stock	...	...	...	7½— 7⅝	7 — 7½	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11½— 12	11½— 12	11 15/16	11¾
18,700£	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	110½	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	135 —145	135 —145	138	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	13	12⅜
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18½— 19½	19	...
12,931	Direct Spanish Teleg, Ltd., £4 paid	5	4½%	4 %	...	2 — 3	2 — 3	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10⅜— 10⅝	10⅜— 10⅝	10⅝	10⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	14⅞— 15⅛	14¾— 15⅛	15⅛	14 13/16
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15⅞— 16⅛	15⅞— 16⅛	16⅛	15⅞
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109	106 —109	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	115⅛	114¾
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	15⅛— 15⅜	15⅜—15⅝	1 ⅝	15⅜
62,700£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	...	...	...	102 —105	102 —105	102¼	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	102 —105	102 —105	102⅜	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —117	116¼	...
95,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	...	...	...	102 —105	102 —105	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	102 —105	102 —105	104½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	108 —109%	107 —110%	108½	108
180,227	Globe Telegraph and Trust, Ltd.	10	5½% §	4½% §	4⅜% §	8½— 8¾	8½— 8¾	8¾	8½
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅜	15⅛— 15⅜	15⅜	15 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	21⅞— 22¼	21 — 22	21¼	21
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	42 — 45	42 — 45	44	43
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	107 —110	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	2 — 3	2 — 3	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅝— 4¾	4½— 4⅝	4¾	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	14 13/16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14½	14 5/16
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5¼— 5½	5¼— 5½	...	...
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	113 —115	113 —115	114⅝	113⅝
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid ...	1	2½%	3⅝%	...	¼— ⅜	¼— ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	113 —118	115½	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	102	100⅜
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 2½	2 — 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	97 —101	97 —101	99	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	6¼— 7	6½— 7	6 15/16	6⅞
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5½— 6	5½— 6	5 11/16	5½
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	1⅞— 2⅛	1⅞— 2⅛	1⅞	1¾
178,200£	Do. do. do. 6 % Debs. "A." 1910 ...	100	...	...	...	103 —106	104 —107	...	...
222,700£	Do. 6 % Mort. Debs, series "B," red. Feb. 1910	100	...	...	...	103 —106	104 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1 — 1½	1½— 1⅝	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	9½— 10	9¾— 10¼	10⅛	9 7/16
4,609	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	8½— 9½	8½— 9½	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	105 —108	105 —108	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	113 —118	113 —118	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	{ Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000 }	5	...	5 %	4½%	4½— 5	4½— 5	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	10½— 11¼	10 — 11	10 1/16	10⅜
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	12⅜— 13¼	12⅜— 13¼	13 3/16	12 13/16
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	...	...	...	5¼— 5⅝	5⅛— 5⅝	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	...	6⅛— 6⅜	6⅛— 6⅜	6¼	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	...	8 — 8½	8 — 8½	8 7/16	8 5/16
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	104 —108	104 — 108	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5½	4¼— 5½	4⅜	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	6¾— 6⅞	6⅛— 7	6⅜	6 1/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8⅛	8⅜	8 3/16
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	5½— 6	5⅜— 6⅛	5 11/16	5⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. Dividends paid in deferred share warrants, profits being used as capita

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 14th.	Closing Quotation, February 21st.	Business done during week ended Feb. 21st, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 2⅞	2⅜ — 2⅞	2 13/16	2⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	2 5/16	2 3/16
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	104 —106	105 —107	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32 xd	27 — 32xd	29½	28¾
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 4	3 — 4	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	96 —101	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ⅜	¼ — ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845	2	...	...	...	1½ — 2	1¼ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750	2	*nil*	*nil*	*nil*	⅛ — ⅜	⅛ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	⅜ — ⅝	7/16 — 11/16	⅝	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm.	2	*nil*	*nil*	*nil*	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½ — 5½	4½ — 5½	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600	10	7 %	...	...	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd.	10	12½%	12½%	12½%	24 — 25	24 — 25	24 9/16	24
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
11,334	International Okonite, Ltd., Ord., 22,667 to 34,000	10	5 % §	...	...	1 — 2	1 — 2	...	...
37,500	Liverpool Overhead Railway, Ord.	10	...	...	1 %	4⅞ — 5⅛	5⅛ — 5⅛xd	5 5/32	5
6,295	Do. do. Pref., £8 paid	10	...	...	...	8⅞ — 8⅞	9 — 9⅛xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2⅛	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	42 — 44	40 — 42	42½	41
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	..	...	... ...	... ...	...	...

‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅞.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅛—6⅞.
Liverpool Electric Supply, £5 (fully paid), 6½—6¾.
Do. do. £3 10s. paid, 4⅛—4¾.
London Electric Supply Corporation, £5 Ordinary, ¾—1⅛.
Manchester Edison and Swan Company, £9 (£1 paid), ⅛—⅝.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—108.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4⅛—4¾.

Bank rate of discount, 2½ per cent. (February 1st, 1894).

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

Messrs. Anthony Hordern & Sons, having again built a large extension to their premises, awarded the contract for lighting it to the Crompton Electric Supply Company of Australia, who have just completed the work. The building is a seven-story one, and the contract was for 1,000 lights, of which 874 have at present been installed. There are two Edison-Hopkinson and one Crompton dynamos, each of 110 volts and 275 ampères, compound-wound, and coupled direct to three Paxman engines of the vertical marine type, with 9-inch and 14-inch cylinders, steam being supplied from two multitubular boilers made in Sydney by the Morts Dock and Engineering Company. The main cables to the switchboard are carried overhead on insulators attached to iron brackets bolted to the ceiling, the original intention having been to have bare mains in a conduit under the floor. The main switchboard is a very handsome white marble one mounted in polished cedar and divided into panels. It is so arranged that any dynamo can be put on any circuit. Heavy plug switches are provided for short-circuiting and cutting out the ampére-meters.

The installation is carried out on the distributing-board system, there being no joints in the cables in any part of the system. A special shaft has been built for carrying the main cables. Henley's, London Electric Wire Company's, and Callender's cables have been used of seven standard sizes, *i.e.*, 37/12, 19/12, 7/18, 7/20, and Nos. 14, 16, and 18.

The installation in the old buildings supplies a total of 1,300 16-C.P. incandescent and four arc lamps, and comprises an Edison-Hopkinson 110-volt 430-ampère dynamo, coupled direct to 100 H.P. twin tandem compound engine, having two 8½-inch and two 16-inch cylinders, engine and dynamo being on same bedplate; and two 110-volt Manchester machines, one giving 480 ampères and the other 200 ampères, driven from counter-shafting by two compound Fowler engines of 60 H.P. each, steam being supplied from multitubular boilers made by the Morts Dock and Engineering Company. The plant has not been put down all at once, but has been extended from time to time, Messrs. H. H. Kingsbury & Co., the Williamson Electrical and Engineering Company, and the Brush Electrical Engineering Company all having had a finger in the pie at various times.

There are 33 circuits in all, varying from 18 to 120 lamps each, three or four circuits having a common return. The old buildings having been added to and increased from time to time, have not lent themselves so readily to the distributing board system as the new building. The whole installation, which is bigger as regards actual lighting than any central station in New South Wales, comprises 2,300 16-C.P. incandescent and 6 arc lamps contained in six buildings.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Some Notes on the Electric Lighting of the City of London.

(*Read by Major-General Webber on February 8th*, 1894.)

(*Continued from page* 195.)

Distribution.

Outside the Postal Telegraph and the City engineer's offices there was no one who could form any accurate idea of the condition of things below the surface of the City streets.

The subways in Victoria Street, in Arthur Street, and in the Holborn Viaduct, although suitable for through mains of supply of any kind, were eminently not so for electric distribution conductors, which have to be tapped at frequent intervals for the supply of current for public and private lighting. Although forced to use them, the cost of such mains and services to a supply company is higher than if the lines were laid under the footway on either side.*

* In March, 1890, the London County Council, with the approval of the Board of Trade, and the confirmation of the Home Secretary, under the terms of the Metropolitan Subways and Government Acts of 1868 and 1888, had published bye-laws for regulating the use of subways. These, while in force in the Queen Victoria Street subway, are not so in those under the Holborn Viaduct and Arthur Street.

Anyone who has used street subways for electrical conductors, in common with gas, water, and other companies, will understand that,

My own Postal Telegraph experience in 1871 and 1872 had been in the difficult ground in thoroughfares like Cornhill; and although in 1891 and 1892 places were come upon where hardly a single conduit could be laid, the task, owing to the system adopted, proved, on the whole, less difficult than was anticipated; and, as was expected, generally, the thoroughfares running north and south were easier than those east and west, for the reason that most water, gas, and telegraph, mains, tend from the City towards outside centres in those directions.

The pioneer work included the opening of certain main thoroughfares, so that the arc lighting might be got forward.

In these, the most thronged streets of the City, it was essential not to have to repeat the inconvenience of opening the ground. Whatever was laid down at the first operation had to form a portion of, and suffice for, the completed scheme.

In a matter so long under my own consideration I had no hesitation in recommending that sufficient conduit accommodation should be provided, and that it should take the following form, viz.:—*

(*a*) Iron pipes for concentric high-tension mains from the generating to the transforming stations.

(*b*) Iron pipes for continuous-current high-tension mains for the public arc lighting.

(*c*) Bitumen concrete casing for three ways, to accommodate the conductors of a low-tension distributing system, both feeders and distributors.

except for primaries, the electrical engineer would much rather remain outside.

The bye-laws are excellent for the regulation of this user, but the panacea which excellently-intentioned persons believe exists in street subways falls short of theirs and the public's expectations.

The law allows the local authority to oblige us to use them where they exist, and to charge us a rental for that use; but, as the word "pipe" in the Act includes a "tube for wires," and as the rental, irrespective of the number of wires, is £16 per annum for a 3-inch pipe for the 1,200 yards of the Queen Victoria Street subway, and £49 per annum for one under 18 inches diameter for the same length, the way-leave is not very costly, but the cost of using it is extremely so.

Sections of some of the subways, with the conduits placed in each for electric light conductors, are shown.

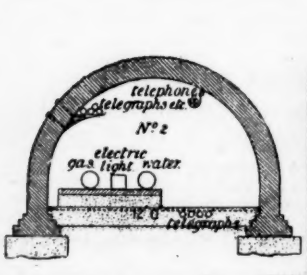


FIG. 2.—HOLBORN VIADUCT SUBWAY.

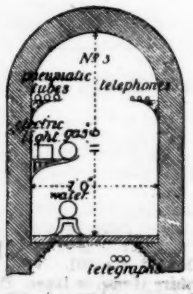


FIG. 3.—HOLBORN VIADUCT NARROW SUBWAY.

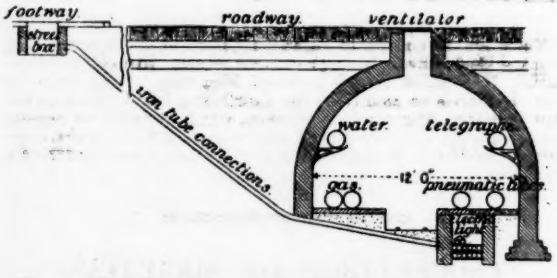


FIG. 4.—SUBWAY, CHARTERHOUSE SQUARE, WITH STREET BOX.

In each case, the obligation to use the subway instead of the ground under the footways entailed one excessive expenditure common to both—namely, the works in breaking through the massive arches and deep cuttings in the roadways to get at the street lamps, and, in many places, to obtain access to the houses, in some places 30 feet away.

In the Arthur Street and Holborn Viaduct Subways a large number of "ways" in Callender-Webber casing have been secured at a very little cost.

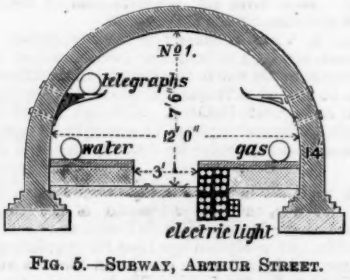


FIG. 5.—SUBWAY, ARTHUR STREET.

In the Queen Victoria Street subway, cast-iron troughing on wall brackets, as first designed, proved an awkward and costly arrangement in many ways; the weight of the structure was nearly 3 cwt. per yard.

Lighter troughing designed by me was adopted, of which follow sections.

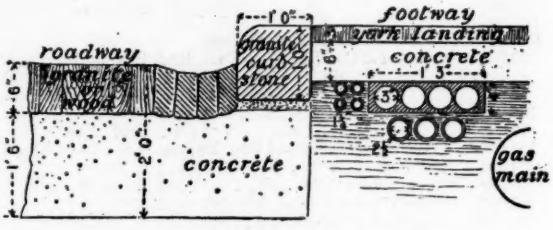


FIG. 9.—SECTION OF ROAD.

The future needs of the great whole had, as I shall describe further on, to be thought out before March of 1891, so that each part of the work, however preliminary, should eventually fit in to the permanent system.

The future need for spare conduits, possibly for telephones, had also to be thought of, and it was provided for as far as the very limited space under the footways of those thoroughfares which were first treated would permit.

The question of interference, through the neighbourhood of alternating current working, with telegraph and telephone circuits, was at that time under public discussion.

I had very little time, and had to be satisfied with one experiment, having the object of observing the screening effect which was anticipated would exist through the interposition of what might be called "faggots" of iron pipes, lying in the same trench as the non-conducting conduits, into which the low-tension distributing mains were to be drawn.

For the experiment, conduits and pipes were laid on trestles under nearly the same conditions as in the trench, and a 200-volt current

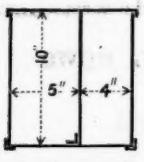


FIG. 6.—SECTION SQUARE TROUGH.

FIG. 7.—SECTION ROLLED-IRON TROUGH.

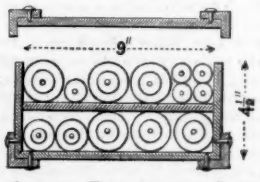


FIG. 8.—SECTION TROUGH WITH CABLES IN IT.

The trough contains cables—six of 1·9 inch external diameter, three of 1·5 inch external diameter, and four of 0·7 inch external diameter; with a carrying capacity in section of copper available at 2,000 volts = 0·09 inch, at 200 volts = 2·1 inches. Weight of trough per yard = 90 lbs.; cost of trough, fixed, 16s. per yard—with conductors, high-insulation bitumen, £4 2s. per yard run.

The essential objections to working in such subways (apart from maintenance) are:—(1) The difficulties, physical and otherwise, of access to them, both for *personnel*, material, and plant; (2) the delays to work, due (*a*) to defective lighting, (*b*) time required to communicate with the authority and other occupiers, (*c*) to foul atmosphere; (3) the engineering obstacles due to the works of previous occupiers, and to the cutting in and out where necessary to reach side streets.

* The entire responsibility of thus advising the pioneer company rests with me. As the pioneer contracts (with the making of which I had nothing to do) had only provided conduits sufficient for the cables from the pioneer generating stations, and had specified nothing as regards the underground conditions, it was necessary, in order to prevent the consequent waste of having to excavate the same ground twice, to make additional provision. And as the isolated areas treated by these pioneer contracts had to be considered as forming a part of the great whole, the whole of the details of the completed work had to be gone into.

with 100 frequency (obtained by transformation) and 100 ampères was passed through two of the three ways of a bitumen concrete conduit, in conductors having a sectional area of copper of about one-tenth of an inch. Telephone circuits with metallic* returns laid parallel were tried. The iron tubes were placed at various distances and in various numbers.

Imperfect as the trial was, it gave us security that at a distance of 12 inches from the Callender-Webber casing, twin telephone circuits in iron pipes would be fairly secure from trouble. But, as an additional precaution, it was decided to sheath the casing with iron. Within a distance of about 6 inches a very slight disturbance could be still heard. A sample of casing thus treated is on the table amongst the other samples illustrated.

The choice was further justified, because the Duke of Marlborough, with his usual foresight, asked several practical engineers to meet

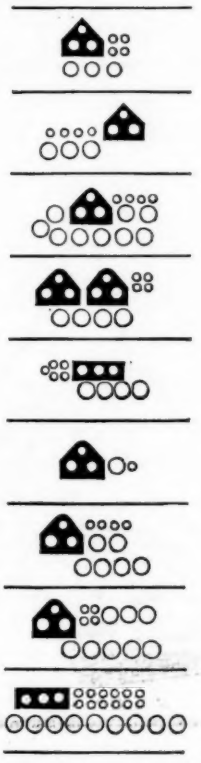


Fig. 10.—Various Typical Examples of Sections of Conduits.

him in a friendly way soon after this advice had been given and adopted, in order to discuss the whole question.

From my notes of that meeting, held on March 23rd and 24th, 1891, I find the conclusions then come to coincided with the system above referred to, which was already in course of execution.†

The following recommendations were formulated, with general concurrence:—

1. That a separate way should be provided for each separate conductor, for the purpose of drawing in and out between flush-boxes.

2. That the high-tension primary alternating currents should have concentric conductors with vulcanised rubber dielectric, and be drawn into iron ways.

3. That the arc lighting continuous current conductors should be concentric, and drawn into an iron way, except in the lengths where the circuit is connected with lamps, when the 7/16 conductors should be separate, so as to avoid joints.

In connection with the secondary distributing conductors, the use of the three-wire system having been admitted, various means of laying were examined—such as large iron pipes, with and without interior separate ways for the cable; the use of paper tubes in iron cases; iron tubes lined with bitumen; and earthenware cases, with ways similar to the Callender-Webber bitumen concrete cases.

After carefully considering the conditions of the City streets, and all the circumstances of difficulty that were being met with and known to exist, the use of bitumen concrete cases with separate ways; and, in view of the experience and evidence of its efficiency, the use of Callender's bitumen insulation for the secondary distributors met with approval.

After hearing all that was to be said as to the conditions for providing drawing-in and joint boxes in the City streets, no doubt remained as to the necessity for using a common box in most situations for all main circuits and their joints, and of making them as large as the space below the surface would permit.

The justification of the adoption of these resolutions was, both from the engineering and financial point of view, as follows:—

The use of footways wherever possible had been prescribed by the commissioners. In spite of having to keep 6 inches under the lower side of the paving-stones, it entailed less labour in excavating.

In the lines where they had to be carried under roadways, the conduits had to be below paving and concrete, sometimes 2 feet in thickness, and with a surface subject to such traffic, the numerous draw, service, and other flush boxes would have been impossible.*

The space available below the surface was occasionally entirely occupied by cellars, areas, and other pipes, and the work had to be carried out in the presence of officials representing—

1. The Commissioners of Sewers.
2. The Postmaster-General.
3. The Gas Light Company.
4. The Water Company.
5. The Hydraulic Main Company.
6. The District Surveyor.

The condition, exacted rigorously—namely, that no pipe or conduit should be placed vertically over, or within 6 inches horizontally of, an existing pipe—was a most arduous one to fulfil.

My procedure in the most difficult streets was as follows:—

Having decided on the maximum number of "ways" that should, and if possible be, laid under the footway, I began by examining it personally, having first obtained from the authorities I have named all possible information as to their pipes—information that was sometimes very imperfect. I then measured carefully all cellars, arches, and areas, and had trial holes opened wherever exceptional difficulty was anticipated. In many cases, such as in King William Street, so contracted was the space, that several ways which were actually necessary had to be omitted and taken another way, and occasionally a deviation under the roadway was obligatory.

The intricacies of the trench opened under such conditions could not, I believe, have been followed with any other system of ways—namely, the combination of Callender-Webber casings and wrought-iron tubes. Both these are capable of being bent on the ground to any reasonable curve—in the case of the iron pipes by the ordinary means, and in the case of the bitumen concrete cases either by warming the case and bending it when soft, or by laying short lengths and setting them at an angle to one another with mitred ends; the length of the short pieces and the angle of the mitres being, of course, dependent on the radius of the segment of the curve that has to be followed.

The difficult problem that faced the company in August, 1891, was the obligation to lay down their mains and complete the public lighting in all or parts of 53 streets by February, 1892, requiring approximately 17 miles of trench; and that the commissioners were likely to be very stiff as to punctuality.

A careful consideration of the case in its various aspects had led me, when acting (up to and before 1890) as technical adviser to the Brush Company, to regard the adoption of alternating currents, delivered at high pressure and distributed at low pressure, as the service most suitable for private lighting in the City.

There was no hesitation on the part of all concerned to adopt it, particularly as in the case of the contractors the Mordey and Thomson-Houston systems had in 1890 reached considerable perfection.

The conditions which emphasised this view in my mind were geographical and local as regards the City. Whatever may have been the ultimate practice, they were paramount during the preliminary stage. They were, first, on account of cost of ground, that the generating stations should be at a distance; second, on account of the exceptional difficulties in the streets for laying mains, the desirable frequency of converting stations might be impossible to achieve.

When the concessionaires (*i.e.*, the contractors) had the matter in their own hands, the sites already named for the generating stations were secured in, or in close proximity to, the City. Although this was a reversal of conditions, the selections were probably wisely in-

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* Experiments made in 1880 with telephone circuits with and without earth returns, between Paddington and Westbourne Stations, laid in the same wooden troughs as 40 or 50 working single- and double-current telegraph circuits, saved me from having to make any trial with earth return for the telephones.

† Those present at this meeting were:—The Duke of Marlborough, Messrs. T. Callender, Gordon, Gray, Heaviside, Mavor, Raworth, A. Siemens, Wharton, and Major-General Webber. It is not to be assumed that unanimity on matters of detail was expected or arrived at. As regards anticipated electrical troubles, the avoidance of interruption of telegraph and telephone circuits was the only thing dealt with at those consultations.

Those present had till then had, I must presume, no practical experience of the resistances due to skin effect, or self-induction, in the case of single conductors of over one-third of an inch section of copper used to convey alternating currents at *low* pressure.

The use of concentric lead-covered cables laid in the earth, with iron split-tube protection where joints have to be made, was discussed with the advocates of that system as used in Germany, and its advantages, both as to reliability, manageability, and first cost, in comparison with two or more highly insulated conductors in one iron pipe, were weighed, especially in view of the claim that, wherever laid, it is everlasting.

The question of influence on telegraphs and telephones, and the means of screening or damping down the magnetic field, was discussed, and various experiences at Bath, Newcastle, and in London were quoted.

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* The following figures give an idea of the traffic in the City:—By bridges, streets, railway stations, landing piers, and subways, there are 81 means of public access. By these the *daily* traffic was—

		1881.		1891.
Vehicular—During 16 hours	...	66,909	...	85,286
During 8 hours	...	4,984	...	6,546
Pedestrian—During 16 hours	...	739,640	...	1,100,636
During 8 hours	...	57,923	...	85 458

fluenced by question of facilities for sea-borne coal and condensing water, and largely controlled by the difficulty created by the Electric Light Acts in getting way-leaves through the areas of neighbouring local authorities.*

The facility, or otherwise, of obtaining sites for transforming stations could not be fully gauged during the preliminary stage, and space underground to be found for large conductors could only be expected to a very limited degree. If we had only known as much as experience has since shown, it is quite possible that a continuous-current system of distribution would have had as good a chance of being adopted as the alternating system.

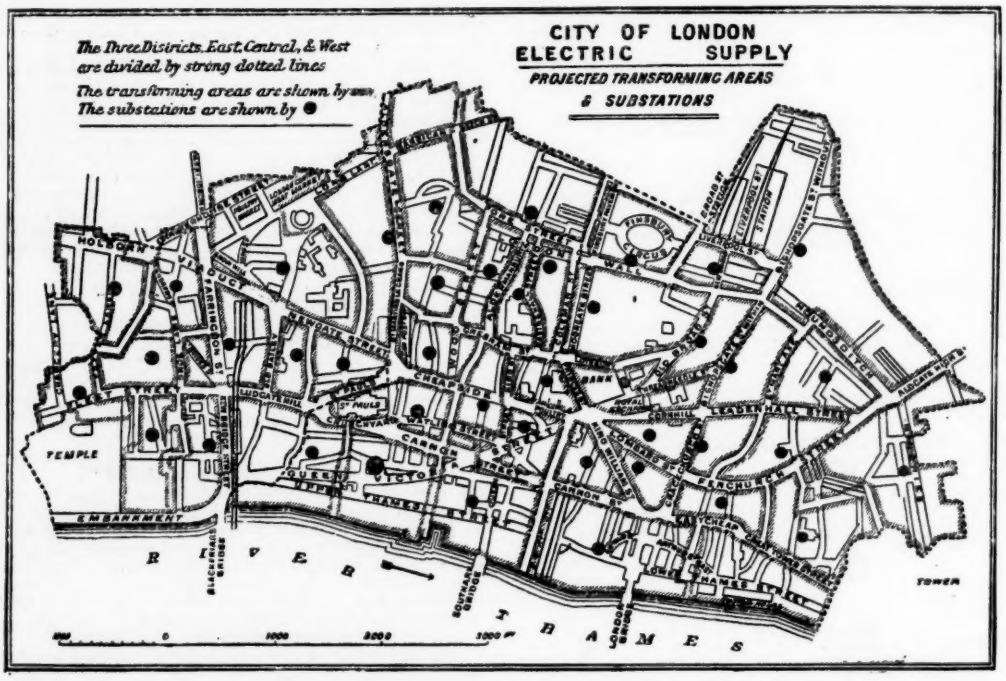
Distribution with low pressure from transforming stations entailed a network on the well known lines, with distributing service mains and feeders. When the time arrived for the City to be divided into areas, each to be served by a transforming station, with all the stations, if not the areas, intercommunicating, the areas and points for the stations had to be approximately assumed, and the number of ways

Drainage, and access of gas from surrounding soil, are conflicting conditions. The drainage had to give way unless some nearer outlet was evident, and the boxes were made as gas-tight as cement and glazed or impervious bricks could make them.

This question of the presence of explosive mixtures in street boxes has, as my audience knows, been several times brought to notice by explosions—one lately in the Western district, on Ludgate Hill. My own view of this particular condition of danger has been to do everything to prevent the coal gas getting into a box, and I believe this can be secured with proper precautions, apart from the occasional possibility of being able to ventilate by in-draught and out-draught ducts.

The precautions are:—(*a*) Good joints between case and case, ensured by finally passing the red-hot "mouse" through each joint after the casing has been laid; (*b*) absence of air space between the cases and the iron sheathing; (*c*) careful sealing-in round the iron tubes and bitumen cases where they pass through the wall of a box;

Fig. 11.—Map of Whole City, showing Transforming Points.



estimated that would be required under each footway throughout the whole City. It would have been, of course, easier to have first found sites for the sub-stations, and then arranged the areas to be served by them; but as the main thoroughfares traversed the City throughout in all directions, there was no area that was not touched by the work requiring immediate completion, so that, to be able to get the above-named 17 miles done, all had to be considered in advance.

The combination of casings with 1¼-inch and 2¼-inch pipes required a minimum sectional area of trench varying according to locality, and if the soil below the footways had been comparatively free, there would have been little difficulty in arranging the position of the ways relatively to one another, so as to suit all requirements.

It was essential—

(*a*) To place them so that the relative positions of the ends should coincide at any rate between box and box, no matter what might be their vagaries in the interval.

(*b*) That, where the trench was opened alongside of a line of pipes enclosing telegraph conductors, the mass of the iron pipes should be laid between the alternating low pressure conductors and the same, to aid in screening the inductive effect on the smaller currents.

(*c*) That the ways destined to be used for the arc lighting, and for the distribution in the street itself, should be nearest the surface. As it was, the fulfilment of these and all other conditions I have mentioned was often absolutely impossible.

The obligatory positions of boxes for drawing in and out, and for access to the cables (exclusive of house service and street lamp boxes, which were only for access to the cables required), were numerous, as it was necessary to place one at every street corner, and wherever a serious change of direction occurred. Still, the lineal space of line of main occupied by boxes was, on an average, only about 2 yards in every 100. These boxes were made as large as possible, which is not saying much; I aimed at making them large and deep enough for a man to get entirely inside, but this was rarely possible. Owing to the obstruction underground, they are of every conceivable size and shape.

(*d*) careful plugging of all "ways" not in use, and caulking with tarred yarn round the cables where they emerge from the "ways;" (*e*) the use of drainage only where the pipes are sure not to become ducts for gas; (*f*) ordinary care in the use of lights until gas is clear.

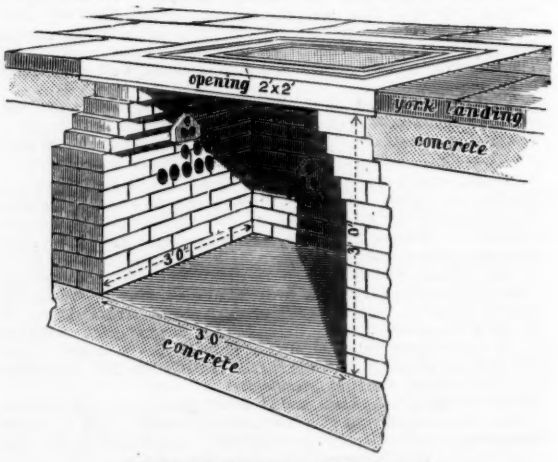


Fig. 12.—Example of Street Box.

The nature of the material in, and shape of, the frames of the iron covers were the outcome of some experience. Nothing is better than a wide rim to the frame, roughed to prevent slipping, filled in with fine Portland cement concrete, made with very hard material, and allowed some weeks to set. The bad ones—and I see there are some—were the result of want of care and bad material. The wide rim provides space for letters indicating the ownership of the box.

In the trenches opened for that purpose all the conduits for conductors, the need for which in the future could be foreseen, had to be provided:—

* For instance, negotiations extending over three years, with that object only, that I had conducted for the Brush Company with some local authorities on the Surrey side, ended only in obliging the company to seek and obtain a provisional order for the St. Saviour's district.

(*a*) For the public lighting high pressure conductors, concentric in some lengths, separate in others.

(*b*) For the private lighting primary high pressure concentric conductors from the central to the converting stations, and between the latter.

(*c*) For the three-wire feeding mains to points in the network. (See various sections of casing.)

(*d*) For the three-wire distributing low pressure conductors of the network. (See various sections of casing.)

(*e*) For the pilot or signal wires for the service of the company—one in each trench.

(*f*) For spares and the future use of telephone conductors—as many in some places as 23—as the probable future demand indicated.*

As an under-estimate of the number and size of these meant a waste later on, in having again to open the streets, and as an over-estimate would be also wasteful, it was imperative, as I have said, to make a careful study of the whole.

This was done with an accuracy only diminished by the following:—

(*a*) The number of existing lights that might be expected within a given number of years to be replaced by glow lamps.

(*b*) The selection of the boundaries of the areas, and approximately of the points for the transforming stations.

(*c*) The desirability, though not an essential, of arranging the areas so that the difference between the consumption in each should not be too great.

To the difficulties in finding sites for stations, and to the unforeseen obstructions to be encountered underground generally, all these became subordinate.

Careful canvassing of the City in various typical blocks of buildings (a "block" meaning all buildings situated between the nearest streets which meet one another) showed that they might be roughly classified in three, and that the number of existing lights, or lamps, averaged as follows, per square yard of ground space, was:—

	Central.	Eastern.	Western.
First-class blocks, per sq. yd. ...	0·254	0·275	About the
Second-clas „ „ ...	0·171	0·171	same as the
Third-classs „ „ ...	0·067	0·100	Central.

Another canvass led to the conclusion that the proportion of those existing lamps that might be expected to be replaced by glow lamps was:—

In the first-class blocks	0·75
„ second-class	0·50
„ third-class	0·33

The above figures were applied, and, the blocks being all classified, and grouped in areas, so that each area might, as has been stated, have approximately the same number of lamps, the following results were obtained; and, although it will be a very long time before its general accuracy can be tested, I feel sure that, so far as the number of lamps is concerned, it is not very far from the truth, although the number of areas may vary very much from the estimate.

For the three districts the following figures were arrived at:—

Glow Lamps.

	Eastern.	Central.	Western.	Total.
18 areas	139,900	...	...	...
14 „	...	100,750	...	...
12 „	...	...	99,547	...
Total, 44 areas	...	...	...	340,197

If these are 8-C.P. lamps of 33 watts, this will give a load at the lamp terminals of 11,226·5 kilowatts. With 96 per cent. in the transformers at full load (the efficiency specified under the contract), and 5 per cent. loss in the mains, primary and secondary,† the output of alternating current of the three stations—namely, 12,100 kilowatts—is not far short of 12,236 demand the maximum possible load, so that with 80 per cent. of the lamps alight there would be nearly 20 per cent. spare generating plant.

If it may be assumed, also, that each 8-C.P. (33-watt) lamp uses 18 units = 6,123,546, with 20 per cent. spare, the load factor comes out = 13·8.

The design of 44 converting points in those districts required that, including spares, each transformer station should have, on an average, 275 kilowatts capacity.

The three first permanent sub-stations, the sites of which were secured by, and the structures designed by, myself, were:—

1. Pancras Lane (Bennet Shere-hog), with space for transformers having a capacity of 450 kilowatts.
2. Nicholas Lane (St. Thomas Acorn), with space for 480 kilowatts.
3. Queen Victoria Street (St. Nicholas Cole Abbey). This is a double station, and has space for 648 kilowatts.

Of these, I only show the design of the first, it being situated under exceptionally difficult conditions.

Transformation.

As has been said, little progress could be made with the selection of sites for permanent transformer stations before July, 1891, as the general scheme, upon which their relative positions much depended, was still under consideration.

To distribute the current generated in the pioneer stations, three temporary transforming stations were improvised, viz.:—

One in Queen Victoria Street, in the basement of No. 47.

One in the basement of the Mansion House.

One in St. Swithin's Lane, under a restaurant.

In no case were these suited to become afterwards permanent stations, both on account of size and circumstances of surroundings.

In the transformers first delivered the secondary windings gave a pressure of $\frac{1}{30}$th that of the primary; and, as the current is delivered at an E.M.F. of about 2,050, and it had to be distributed in three-wire mains with an initial pressure of about 205 volts, they had to be coupled two in series—an arrangement which would disappear with the delivery of the contract transformers.

It early became evident that the price, by way of rent, that would be demanded for adequate space in, and access to, existing buildings, was prohibitive in the more costly areas. For instance, in Lombard Street, where every square yard is said to be worth £1,000, it can readily be conceived that £500 a year was asked for a small room in the basement. With this in view it behoved us to look for what we required to the space under those portions accessible to the public, or not available for building purposes.

Careful searching showed that many engineering and financial difficulties existed.

For instance, at some points where there was evidently ample space below the surface, a prohibitive price was asked for the means of access to it through private property; and, again, at many such points, space for access within the area used by the public could not be obtained, for various reasons of public convenience and safety.

In time our attention was turned to the old City graveyards, and, after long negotiation with the parish authorities, and with the Consistory Court and the Commissioners, leave was obtained at a fair cost to use a small portion of two of these open spaces in Pancras and Nicholas Lanes, so as to provide shafts for descent to the contiguous chambers to be constructed by leave of the Commissioners under the foot or roadways.

But, even with this facility, the space below was in one case—namely, Pancras Lane—extremely limited, through the existence of large main sewers and water and gas pipes. In excavating, large quantities of human bones were met with, which had all to be transported carefully for extramural re-burial.

(*To be continued.*)

* On this subject, from the point of view of the telephone service of London, I hope to be permitted to read a paper before the Institute at a future date.

† It is quite certain that this ideal condition of efficiency can only be achieved when a completed system is at full work; at lower loads it will often go down to 76 per cent.

NEW PATENTS—1894.

2,451. "Improvements in and connected with electrical concentric conductors." C. R. G. Smythe. Dated February 5th.

2,493. "Improvements in holders for electric incandescence lamps." R. F. Randell. Dated February 5th.

2,514. "Improvements in or relating to electric bells." J. H. West. Dated February 5th. (*Complete.*)

2,524. "An electromotor for fans." Blackman Ventilating Company, Limited. (Communicated by F. Stahl, Germany.) Dated February 5th.

2,548. "Improvements in firing keys or electrical contact makers." H. V. Keeson. Dated February 6th.

2,562. "Improvements in electrical tramways and railways." F. M. Ashley. Dated February 6th. (*Complete.*)

2,593. "Improvements in gas engines." H. H. Lake. (Communicated by W. W. Grant, United States.) Dated February 6th. (*Complete.*)

2,607. "An improved magnetic electric conduit system for electric tramways, railways, and the like." R. Flebbe. Dated February 6th.

2,623. "Improvements in regulating and controlling dynamos." W. M. Mordey. Dated February 6th.

2,677. "An improved printing telegraph and transmitter." C. A. Beck and L. Kamm. Dated February 7th.

2,693. "Improvements in or connected with phonographs." E. O. Kumberg and B. E. Clarke. Dated February 7th.

2,721. "Improvements in and connected with insulators for supporting electric telegraph, telephone, and similar conducting wires." T. Sewell and H. Bodtker. Dated February 7th.

2,730. "A new and improved protector for electric cables laid underground." T. B. Grant. Dated February 8th.

2,733. "Improvements in or relating to the regulating mechanism of electric arc lamps." W. C. Mountain and G. T. O'B. Carew. Dated February 8th.

2,734. "An improved electrical contact screw." J. H. Kerr. Dated February 8th.

2,749. "A new or improved register and holder therefor for recording telephonic messages." D. Denison. Dated February 8th.

2,790. "An improved electric registering apparatus for recording the speed and occupation of vehicles." F. Klaege. Dated February 8th.

2,806. "Improvements in electrolytical decomposing apparatus." C. Kellner. Dated February 8th.

2,812. "Improvements in methods of and apparatus for the generation of electric currents of defined period." N. Tesla. Dated February 8th. [Date applied for under Patents, &c., Act, 1883, Section 103, August 19th, 1893, being date of application in United States.] (*Complete.*)

2,851. "Improved electric signal apparatus." W. P. Thebrmann. Dated February 9th.

2,866. "Improvements in and having relation to dynamo-electric machines" W. L. WISE. (Communicated by I. N. Lewis, United States.) Dated February 9th.

2,897. "Improvements in the manufacture of coke or carbon for electrical or other purposes." C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER and J. L. DOBELL. Dated February 9th.

2,900. "Improvements relating to the electro-deposition of metals." J. RUDHOLZNER. Dated February 9th. (*Complete.*)

2,936. "Improvements applicable in connection with telemotor apparatus for actuating mechanism at a distance for telegraphing, indicating, steering, and analogous purposes." A. B. BROWN. Dated February 10th.

2,965. "Improvements in holders for incandescent electric lamps." J. H. GEISENHEIMER and E. A. LESSING. Dated February 10th.

2,968. "An improvement in electrolysing liquids and apparatus therefor." O. IMRAY. (Communicated by the Farbwerke vormals Meister, Lucius, and Brüning, Germany.) Dated February 10th.

2,976. "Improvements in casings and fittings for electric wires and lights." H. V. LANCHESTER. Dated February 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

519. "Improvements in electric resistance boxes or coils." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated January 10th. Relates chiefly to methods of coupling and combining the resistances. 3 claims.

3,285. "Improvements in electric railway signals." F. H. CLARKE. Dated February 14th. Consists essentially of electrical generators carried by the engines or trains and producing electric currents, preferably constantly alternating, together with a series of electrical conductors adjacent to the railway bed and forming a system of overlapping blocks, so that should one train enter upon a given stretch of track already occupied by another train, that fact will be audibly announced in both trains, or as many as may enter or be upon such stretch—the announcement being made in either or both directions—forward or rearward. 6 claims.

3,675. "Improvements in and connected with telephone transmitters." E. L. MAYER. Dated February 18th. Embraces (*a*) a combination of parts constituting a new or improved double-cycle transmitter, and (*b*) an arrangement of circuits for use with double-cycle transmitters or with the inventor's four-cycle transmitter. 5 claims.

4,368. "Improvements in electric arc lamps." B. B. WARD. Dated February 28th. Consists of a double or multiple arc lamp having two or more independent regulating mechanisms, and two or more corresponding feed controlling magnet systems in continuous operative connection with the electric circuit. 4 claims.

4,923. "Improvements in conductors in telescopic standard lamp holders for electric lamps." A. G. NEW. Dated March 7th. Consists in coiling an ordinary insulated double flexible conductor—attached at the end to the top of the sliding tube and electrically connected with the lamp and at the other to terminals at the bottom of the standard inside the movable tube of the extensible lamp-holder. 1 claim.

5,911. "An electric contact-maker for ringing bells and for other analogous purposes." J. R. MANN. Dated March 20th. Claim:—An electric contact-maker, consisting of a ball or other piece of metal attached to a cord in such manner that the pulling of the cord brings the ball into contact with the two terminals, and completes the circuit, substantially as described.

6,556. "Improvements in electrical instruments for medical purposes." H. H. LAKE. (Communicated from abroad by Boyd's Medico-electrical Vitaliser Company, of America.) Dated March 28th. Consists of a combination cylinder, closed at both ends, and formed of a number of short cylinders of zinc and other metals together with alternate cylinders of celluloid or other insulating substance. 1 claim.

6,952. "Improvement in electrically-heated crucibles and holder therefor." W. MITCHELL. Dated April 4th. Consists partly in a crucible consisting of two insulated parts, and also in the combination therewith of a holder connected with circuit wires, and having terminals in contact with these parts respectively. 3 claims.

6,975. "Improvements in or connected with apparatus for periodically completing and interrupting electric circuits." E. L. BERRY and F. HARRISON. Dated April 4th. According to this invention the requisite changes of contact are made by means of a solenoid, or of solenoids, in a shunt from the main in which shunt the current is not sufficient to cause injury of the contact devices. The core or cores of the solenoid, or solenoids, makes, or make, and breaks, or break, the contact or contacts for the completion and interruption of the circuit in the main supply, the contact or contacts preferably consisting of mercury cups immersed in a liquid medium of a high flashing point, which liquid covers the contact point and lessens sparking. 3 claims.

7,424. "Improvements in electric arc lamps." A. G. WATERHOUSE and THE WATERHOUSE ELECTRICAL MANUFACTURING COMPANY, LTD. Dated April 11th. Consists of means for producing a constant and steady feed of the carbon rod, by causing the liberating point or surface to move away from the clutch, as the carbon rod or holder moves downward. 4 claims.

7,471. "Improvements in and connected with electric annunciators." E. R. WILDER. Dated April 12th. Consists of the combination of a transmitter, a receiver, and an annunciator, so constructed and operated that any want out of a number of different wants or calls may be transmitted and received at the office after the attention of the clerk or operator has been attracted. 5 claims.

7,758. "Improvements in electric fire alarm apparatus." E. KLOSS. Dated April 17th. Consists of a metallic box, hermetically sealed at a low temperature, to which is connected, but electrically insulated therefrom, a metallic bridge, carrying a milled headed contact point adjustable to make contact with the cover of said box at any given or predetermined temperature, such contact being caused by the rising of the lid of the box, by reason of the expansion of the air enclosed therein, as the box becomes heated by the surrounding atmosphere. 2 claims.

7,865. "Lightning arresters and discharge protectors." ELIHU THOMSON. Dated April 18th. The principal distinguishing feature of the present invention is the manner in which a lightning or other high potential discharge is enabled to pass over a discharge path interrupted by spark gaps, by inducing from such discharge in a proper circuit a secondary discharge or discharges of greatly increased potential, such as will leap a space between electrodes placed at a considerable distance apart. 2 claims.

7,866. "Lightning arresters." ELIHU THOMSON. Dated April 18th. Consists in locating the lightning arrester in a shunt around the dynamo, or other apparatus, from the line or main to the connection leading from the dynamo, or other apparatus, to the ground. 3 claims.

8,330. "Improvements in and relating to electric car brakes." M. E. CAMPANY. Dated April 25th. Consists in an automatic brake for cars, which is so constructed that should the cars accidentally break apart, or separate, the brakes will be instantly and automatically applied to each car; using the momentum, or force, of each car to stop it. 5 claims.

9,295. "An improved electrolytic apparatus." T. CRANEY. Dated May 9th. Relates more specifically to electrolytic apparatus, principally designed for the commercial manufacture of sodic hydrate, from common salt, and the invention consists in the peculiar construction and arrangement of the vessel, or receptacle, in which the decomposition takes place, and has for its object, primarily, to render the construction more economical, and, in a form, more adapted for the commercial exploitation of the process of electro been devised heretofore. 3 claims.

9,358. "Improvements in connections for electric lighting and like purposes." G. BINSWANGER. Dated May 10th. Has for its objects the preservation of a good conducting or contact surface, when exposed to the atmosphere out of doors, and, also, the construction of such connections so that they may be readily connected or disconnected when required. 2 claims.

9,552. "Improvements in or relating to microphones and telephones." T. PAETZOLD. Dated May 12th. The purpose of this invention is to improve the clearness and distinctness of tones of the sound produced in telephones and microphones, and at the same time to simplify the construction of such apparatus. 4 claims.

9,818. "Improvements in underground conduits for electrical conductors." J. F. CUMMINGS. Dated May 16th. Consists in the peculiar method of constructing the conduit sections, and further in the construction of the conduit and the junction boxes, and further in the peculiar construction, arrangement and combination of the parts. 2 claims.

10,283. "Improvements in and connected with the manufacture of electrode plates for secondary batteries." J. E. HOFMANN. Dated May 24th. The plates of lead which serve as supports or a foundation for the active substance, are provided with pocket-like recesses arranged at an acute angle to the surface of the plate; in these pocket-like openings the active substance is firmly packed, so that it may not fall out during the forming and the later use. 3 claims.

10,347. "Improvements in or connected with battery switches." H. K. SPANGENBERG. Dated May 25th. Relates to a battery switch having for its object the combination of any desired number of elements or cells of two batteries to be included in and cut out of the current circuit without interrupting the current, and to connect the four poles of these two batteries with two electrodes or poles in various combinations. 2 claims.

10,501. "Improved method of heating liquids by electricity." C. H. PRICHARD. Dated May 29th. Claims:—1. Heating liquids by means of electric vacuum lamps fitted in a vessel to contain such liquid, substantially as set forth. 2. The improved method of heating liquids, substantially as set forth.

11,092. "Improvements in electric batteries." M. L. M. HELLESEN. Dated June 6th. The electrodes are separated only by a single or double layer of fabric or the like, the negative electrode being permanently kept moist, and saturated with exciting liquid by means of a supply of exciting mixture stored in the positive electrode, in order to keep the connection between the electrodes in active condition as long as any depolarising power is left in the depolariser. At the same time a system of ventilation is provided, which, while allowing any gases arising from the cell during action to readily escape, will not, at ordinary temperatures, allow any direct evaporation of the liquid of the cell. 3 claims.